PRACTICAL MECHANICS AND SCIENCE

SEPT 1962

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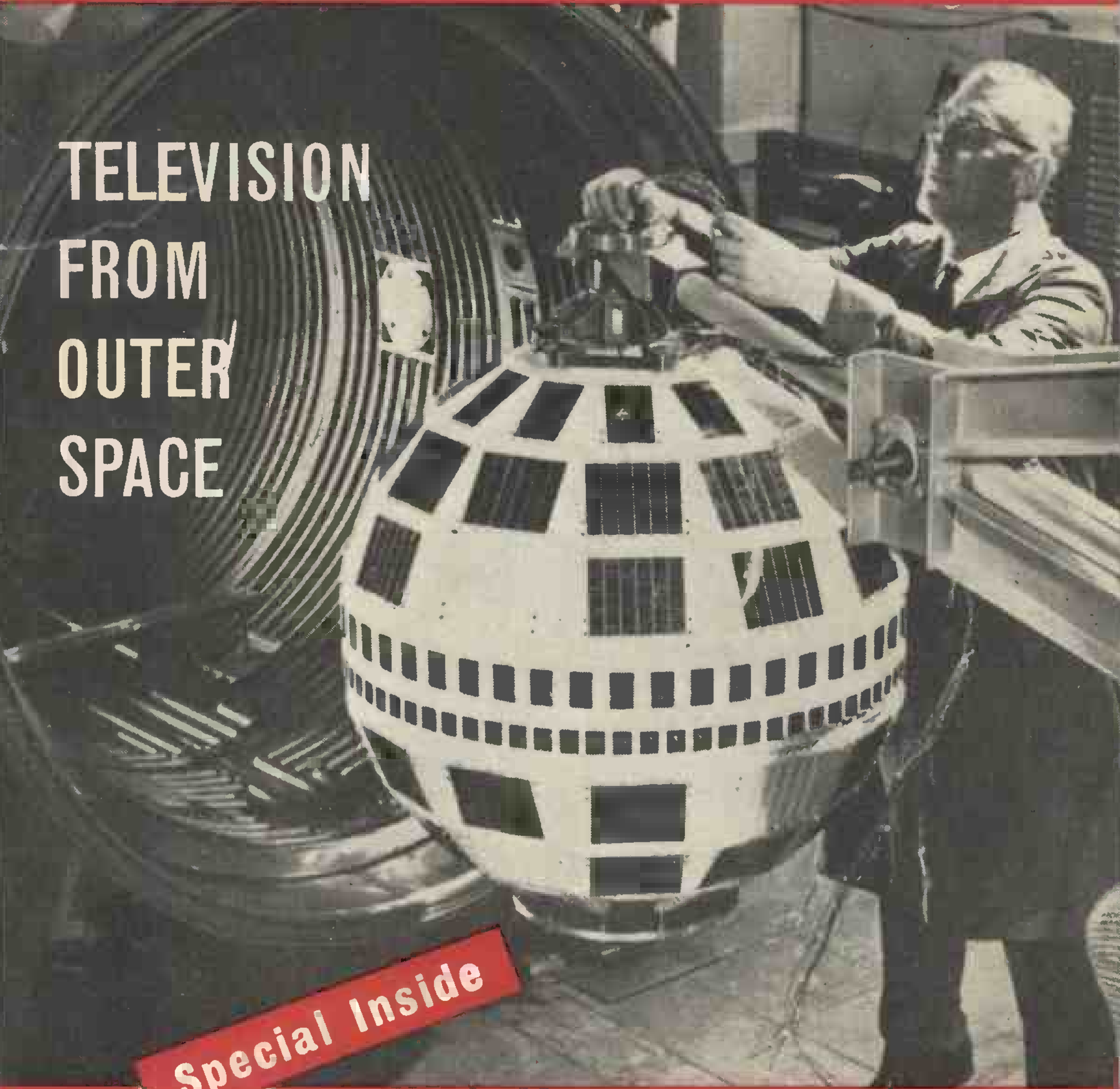

AN AMATEUR CLIMATOLOGICAL STATION

RADIO DIRECTION FINDER ★ ELECTRIC FOOD MIXER

PRACTICAL MECHANICS AND SCIENCE

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CONTRIBUTIONS
The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Mechanics." Such articles should be written on one side of the paper only, and should include the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor, should be addressed: The Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

TALKING POINT

Century 21 Exhibition

WHEN we think about the accomplishments of scientists during the twentieth century, we realise, indeed, that we are living in a very "go-ahead" age. Their achievements have been many and, revolutionary. The uncovering of the secrets of the atom; the complexities of electronics and, recently, the use of the transistor, that tiny device that has replaced the vacuum tube in so many electronic devices and opened the way for innumerable scientific advances in instruments, transmission, radios and television etc. etc.; microwaves, masers, and radio telescopes; and many other things far too numerous to mention; not forgetting, of course, the start of the conquest of space. The scientist's interest, today, ranges from the invisible interior of the tiny atom to the outermost limits of interstellar space.

Life in the Future

With all the good things we have today, what may life be like in the next century? Much of what is foreseen is now being vividly portrayed at the Century 21 Exhibition, in Seattle, Washington. The United States National Science Advisory Board, together with leading scientists in government, industry and research and educational institutions have envisioned the future for us.

The Century 21 Exhibition is based on the theme "Man in the Space Ages", and designed to provide tangible answers to man's conjectures about the future. Two of its chief sections are devoted to cover the World of Science and the World of Century 21. The science exhibit alone cost the United States $3,500 million to set up.

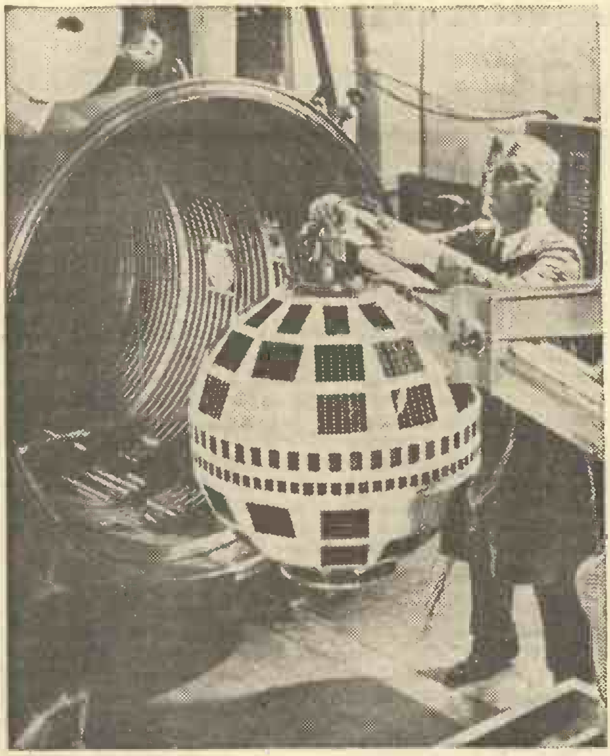
Five sections of the science exhibit deal with aspects of the future. "The Face of the Future" shows the major world problems to which science seeks the solutions; the "Space Age Perspective" enables a visitor to be lifted into space, where he sees time, space and matter in new perspective; "Playground of the Laws" summarises scientific findings to date, giving the layman an understanding of the basic laws and principles of science; the "Spirit of Science" is depicted in tangible form, and "Frontiers of the Future" exhibits ways in which scientific discoveries may provide a solution tc man's problems.

One of the chief attractions to the exhibition is a visit to a rocket port. Here a transparent lift shaft takes visitors up to a full-scale "rocket port", while at ground level, at the other extreme, is a car without wheels, a radically new concept in land transport. Elsewhere, a freight rocket is shown at the moment of take-off on a shuttle service to a supply station in space.

Demonstrations of scientific apparatus, working models, and visual displays are some of the methods employed to help people to explore the vast field of science and its implications for the future. The newest trends and developments in atomic and electrical power, and other industrial enterprises, with prototypes of technological wonders still on the drawing boards, are all to be seen.

The Century 21 Exhibition certainly gives us something to think about. Not only is a new age here but, where do we go from here? Many of the answers, improbable as they may seem now, are all worked out at this exhibition. Science today means the life of the future.

The Oct. 1962 issue will be published on Sept. 28th, 1962. Order it now!



HOW TELSTAR WORKS

THE INNER WORKINGS OF THIS NOW FAMOUS SATELLITE ARE TOLD BY R. J. SALTER

THE launching of the new satellite Telstar is a step towards the day when television viewers in this country and the rest of Europe will soon be able to watch events as they are happening anywhere in the world.

The first advance towards this goal has now been taken by the launching into orbit of the communication satellite, Telstar.

How then is it possible for radio broadcasts to be received from across the Atlantic if television waves cannot span the ocean. The answer is that only certain radio waves known as short-waves are reflected by the ionosphere, a series of electrified layers which girdle the earth. Larger radio waves such as carry television signals pass right through the layer and are lost forever in space.

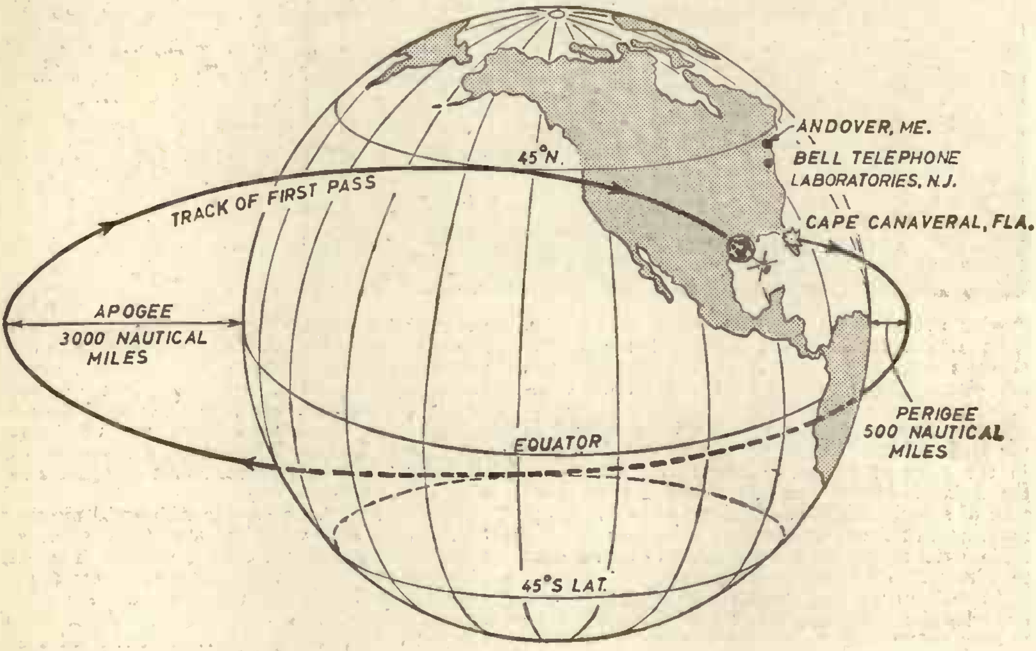
When we receive television programmes from Europe the picture carrying signals are passed or relayed on to us from the cameras covering the event by a series of relay stations which cross Europe and the Channel. The television signals travel in straight lines and are passed from tower to tower across the continents.

Building a series of towers across the Atlantic is not of course possible and so it is to the satellites that scientists are looking as a means of bridging the Atlantic gap.

A satellite can make television, telephone and wireless communications easier because, whilst it is in space high above the Atlantic, signals can be transmitted up to it from a ground station in the United States. The satellite will pick up these signals before they vanish into space and its complicated electronic apparatus will then increase the

Goonhilly Downs Receiving Station.

TELSTAR SATELLITE ORBIT



power of the signal ten billion times and beam it back down to ground stations in Europe. The satellite can do this just as long as it is in view of radio waves from the receiving and transmitting stations. With Telstar this period is about half an hour before the orbit of the satellite takes it out of radio view of one or the other of the two stations.

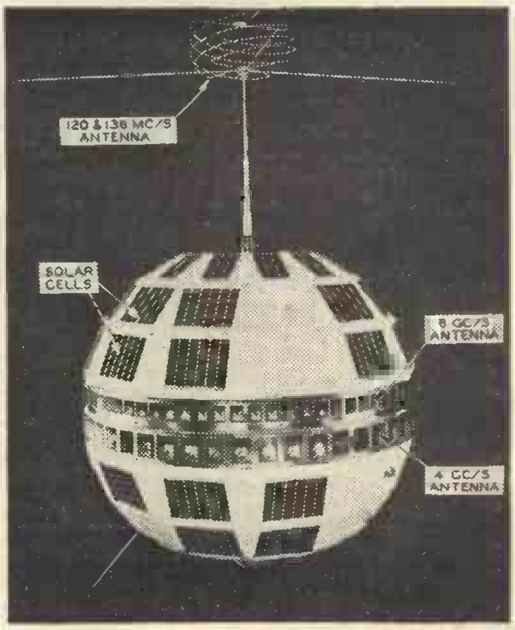
Telstar itself is roughly spherical in shape but like a cut diamond has 72 faces or facets. Just under 3ft in diameter it weights about 170lb when on earth. Power for the operation of the complicated electronic devices within the satellite is being provided by 3,600 solar cells mounted on the facets of the sphere. When Telstar is on the sunny side of the earth these solar cells change the sunlight directly into about 15W of electrical power. Fortunately there are no clouds in space to cut down the power supply.

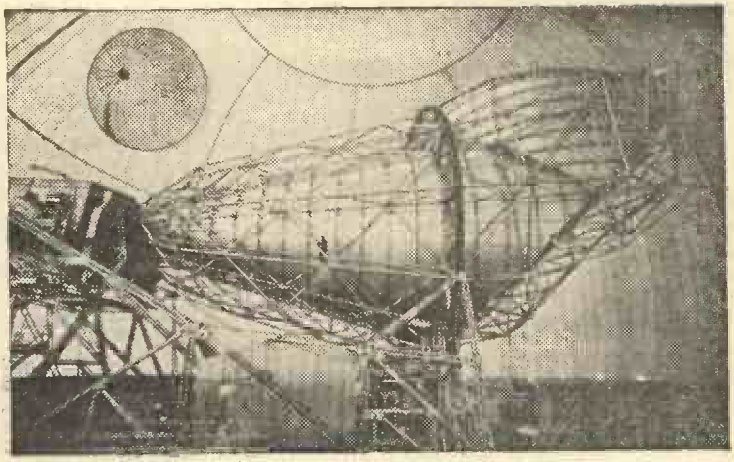
Sending a satellite up into space is expensive, it cost 3 million dollars to launch Telstar and so very great care has been taken to make sure it continues to work for as long as possible once it is in orbit.

The solar cells are mounted on a ceramic base in a platinum frame and covered over with clear man-made sapphire. Even more vital are the electronic receiving, amplifying and transmitting apparatus hidden away inside the magnesium and aluminium shell of the satellite.

All these parts were placed inside an aluminium canister which itself was fastened within Telstar by nylon cord lacings. In this way any shocks experienced by the satellite are not passed on to the instruments within the cannister. To prevent

Telstar.





The Horn-shaped Aerial at the Earth Station at Maine, U.S.A.

moving about within the container a pink plastic foam was poured into it when all the 15,000 separate components had been assembled. When the plastic cooled it held all the electronic components perfectly rigid.

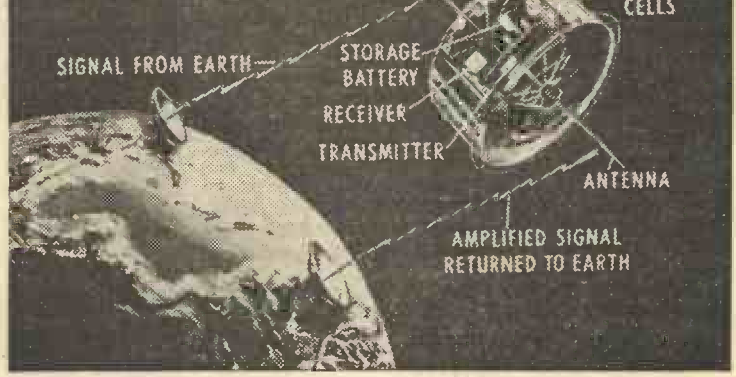
Receiving and sending signals on the ground in the United States is the earth station at Andover in the State of Maine. Situated in the heart of the isolated Appalachian Mountains a great horn type of antenna has been built. So as to follow the movement of the satellite out in space this 380 ton radio aerial rotates on a track made to be accurate to within 30 thousandths of an inch.

As well as rotating on its base a great wheel encircles the aerial so that it can be turned over to keep on track of the moving satellite. Protection from the weather is given by a thin covering of Dacron and synthetic rubber only $\frac{1}{16}$in. thick. It is held in position like a giant balloon by an inside air pressure only one tenth of a pound per square inch above the outside pressure of the atmosphere.

Key to the receiving and transmission of television and telephone signals in this country is the recently built United Kingdom Satellite Communication Ground Station at Goonhilly Downs in Cornwall. This part of the British Isles was chosen so that the satellite would be in view of both this country and the United States for the greatest length of time. Goonhilly Downs too was free from unwanted radio interference and it also gave a clear view of the horizon.

Fitted with a large moving dish aerial measuring 85ft across and weighing 800 tons, steering is performed by 100 h.p. electric motors. The aerial must of course be very accurately steered using information fed from the National Aeronautics Space Administration's Goddard Space Flight Control Centre in the U.S.A. otherwise the signals would miss the satellite altogether.

Telstar is but the first of several communication satellites to be launched this year which will make it possible for viewers sitting in their armchairs in this country to see events as they are happening in the United States and beyond.



Showing how a Satellite in space receives and re-transmits radio signals.

LATHE GADGETS

Part 9

INDEXING GEAR I

By L. C. MASON

TO locate a number of points evenly spaced round a job held in the chuck, such as bolt holes round a cylinder flange or cover, the mandrel can be turned so that each chuck jaw lines up in turn with a fixed mark—when the number required is three or four.

This is not particularly accurate and completely inadequate if a number such as seven is required. Many home workshop lathes have been equipped with means of dividing using the bull-wheel of the backgear—the large one keyed to the mandrel. This works rather better, but is still unable to provide much of a range of possible numbers. The method falls down badly in the case of the ML7 where the bull-wheel has 65 teeth; 60 is a much more convenient number for dividing purposes.

The accessory shown enables dividing to be carried out on the ML7 into any number which can be provided by any one of the standard set of change wheels, which obviously increases the possibilities very much. It consists of two main components; an extension to the back end of the mandrel on which the required gear wheel is mounted, and means of indexing round the selected wheel.

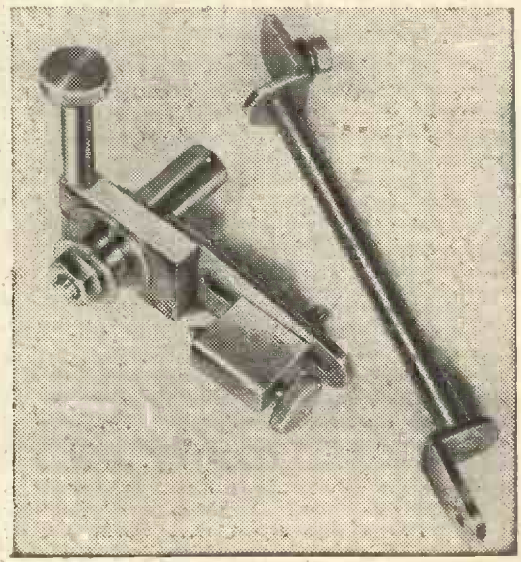
The extension piece is quite well known for use in this way, but in most cases the detent gear engaging with it is somewhat haphazard. Sometimes one sees the advice to use a pointed screw as the detent, tapped through a strip overhanging the wheel and clamped under the rear bearing lubricator. Such an arrangement can never provide accurate dividing as the slightest side-play in the screw or spring in its bracket allows the job to move several degrees either side of the actual point desired. Dividing gear of this sort should preferably feature a really rigid detent with no perceptible side movement at all, and provide means of locking the spindle after location completely independent of the detent. This attachment goes a long way towards attaining these ideals in a simple way.

Components of Mandrel, dividing attachment.

The mandrel extension piece is merely a short length of round bar, turned a close fit in the end of the hollow mandrel. It is drilled thfough $\frac{3}{8}$in. for a drawbolt. The end of the piece housed in the mandrel is taper bored for a short distance and split in four places. The head of the drawbolt is taper turned to match, so that drawing the bolt up tight expands the extension in the mandrel bore and holds it solidly. The nut on the outer end of the drawbolt also holds in place the change wheel, pressing it up against a true shoulder on the extension. Thus tightening the outer nut secures both wheel and extension.

Between the gear wheel seating and the end of the mandrel the extension piece has a truly turned flanged collar $\frac{3}{8}$in. wide and 1in. diameter, which is used for locking the mandrel. A piece of $\frac{3}{8}$in. steel plate is bored a snug fit for this collar and split to permit of clamping tightly on it. A detachable flange ring holds the clamp plate about the collar. The locking plate carries a slotted strip along which can be located a block through which is screwed the detent. By positioning the block close to the wheel, overhang of the detent point can be reduced to virtually nothing. When the whole assembly is locked solid with the mandrel, independent of the detent, mandrel and attachment

Dividing attachment ready for use.



are then free to swing round as a unit. This is prevented by a stout stay, held at the top by the stud securing the detent block and at the bottom by a bolt or stud through the hole in the edge of the fixed plate forming part of the change wheel casing.

Incidentally, newer ML7's than the writer's have this hole slotted out to the edge for easier removal of the gear cover, and it is a worth while minor modification to do the same to those having a plain drilled hole. This also speeds up fixing and removing the dividing attachment.

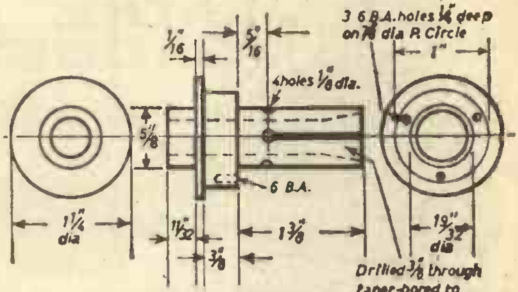
The obvious point at which to start making the gear is with the mandrel extension, but a better idea is to make the drawbolt first. You then have the tapered head available to serve as a gauge in taper boring the end of the extension piece. The drawbolt is straightforward turning, the short taper being produced by setting over the topslide. Leave a short length of plain core diameter beyond the end of the thread; when the bolt has been pulled tightly into the taper it needs a light tap to free it and release the extension. If the end of the thread is repeatedly banged it will soon be difficult to remove and replace the nut.

Make the nominal $\frac{19}{32}$in. end of the extension a close fit in the lathe mandrel bore, then it will not need excessive tightening of the outer nut for a firm fixture. Turn this end and the large collar first, both at the same setting, then drill through and taper bore the end of the hole. Bore out until the end of the drawbolt comes about flush with the extension end when inserted. This turned sleeve end is long enough for holding in the chuck for turning the wheel seat end, and it now has a large turned concentric surface for reference in setting up. Turn the shorter end a shakeless fit in the bores of the change wheels. Lastly, drill the four small holes around the sleeve part and cut the four slits up to meet them.

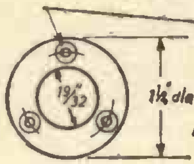
Next comes the block bored to grip the collar, a plain boring job in the four-jaw. Make the hole a close fit on the collar as a little friction is of no account here. When the block is clamped normally round the collar it should be impossible to move it by hand. Drill and tap for the 2B.A. clamp stud and cut the slit, which can very well be done by hand. The finger nut for clamping is, as will be seen, an unusually tall affair. This is to bring the knurled top well to hand, and to ensure that it clears the largest standard change wheel that may be mounted on the extension.

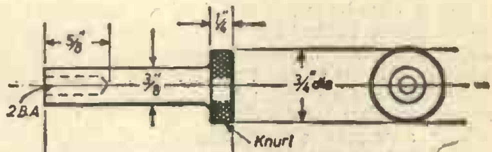
The slotted tail to the block needs no comment, except to mention that the slot should allow no sideways play to the $\frac{1}{4}$in. studs in the detent block. It is most conveniently fixed to the clamp block by flush riveting.

The detent block is also quite straightforward. Two pins in the block ride in the slot; the rear one is a stud serving to hold both block and stay, while the front one is filed down to a shade shorter than the thickness of the slotted plate. It serves to line up the detent. Both can be either silver-soldered or tapped into the block. The detent itself comes to sharpish round-nosed point, which should not bottom between the gear wheel teeth. A wedge contact between the teeth is what is required. The thread is shown as $\frac{1}{4}$in. Whitworth, the coarseness of this thread giving a quicker release and engage action than would a finer thread.

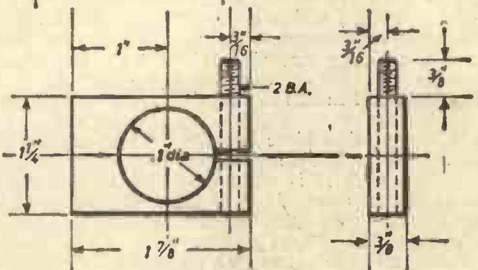


MANDREL EXTENSION

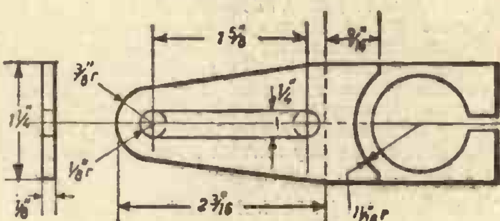

3 C/Sunk holes 6 B.A. clear on 7/8" dia. P. Circle
CLAMP
RETAINING RING (1/16" thick)

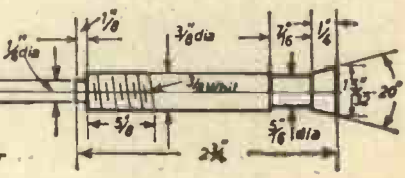


MANDREL CLAMP NUT

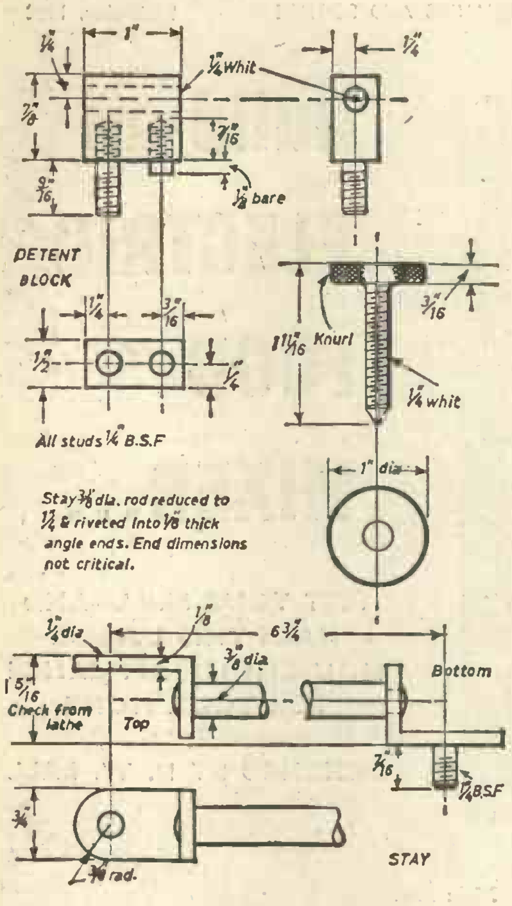


CLAMP PLATE


DETENT CARRIER



DRAWBOLT



For setting up the attachment, slacken off the nut holding the detent block and run it out towards the end of the slot. Remove the wheel nut and washer and mount the selected wheel, leaving the outer nut only lightly finger tight. Assemble to the mandrel end and anchor the bottom stay finger tight. Tighten the wheel nut, till the wheel feels solid with the mandrel. Run the detent right back into the block. and advance the block till it just clears the wheel. Tighten the block fixing nut and the bottom stay nut, screw the detent forward to engage the appropriate tooth space and lock the mandrel with the tall clamp nut. If preferred, the wheel can be marked round before mounting with a chalk mark at each of the tooth spaces to be engaged to avoid counting teeth with the wheel set up. After completing whatever operation was required at each position, slacken off the clamp nut, screw the detent back to clear the wheel and re-engage at the next position, re-clamping as before.

The following table shows the range of divisions obtainable, using a selection of the standard change wheels:

No. divisions	Wheel	Index every
2	60	30
3	60	20
4	60	15
5	60	12
6	60	10
7	70	10
8	40	5
9	45	5
10	60	6
11	55	5
12	60	5
13	65	5
14	70	5
15	60	4
19	38	2
20	60	3
25	50	2
30	60	2
35	70	2
38	38	1
40	40	1
By 5's to 75	By 5's to 75	1

It will be noticed that all the numbers up to six, with 10, 15, 20 and 30 can be obtained by using a smaller wheel than the 60 shown. The 60 is deliberately indicated for the smaller numbers, as it is preferable to divide round as large a wheel as possible for the most accurate results. Should the 60 wheel be already set up in a train for screw-cutting, for example, it would probably pay to slip it off temporarily for the dividing job. If the change wheel stud and sleeve are left in place, no fiddling to re-mesh the train is required on replacing the 60 wheel.

Operator's view of dividing attachment set up.

The finished Mixer.

Build an ELECTRIC FOOD MIXER...

TEST YOUR SKILL—AND MAKE THIS USEFUL HOUSEHOLD APPLIANCE FOR YOUR HOME

DESIGNED BY D. W. BALL

HAVING collected all the parts required, start with the *Base Board* Fig. 1 (1) mark this off to dimensions given in the drawing, mark the position for the main arm, clean the Board up with sandpaper. Drill the hole in the centre to give a tight fit for the *brass bush*. When turning your bush leave it a shade full. Fit the bush in to the Base Board.

The Turntable

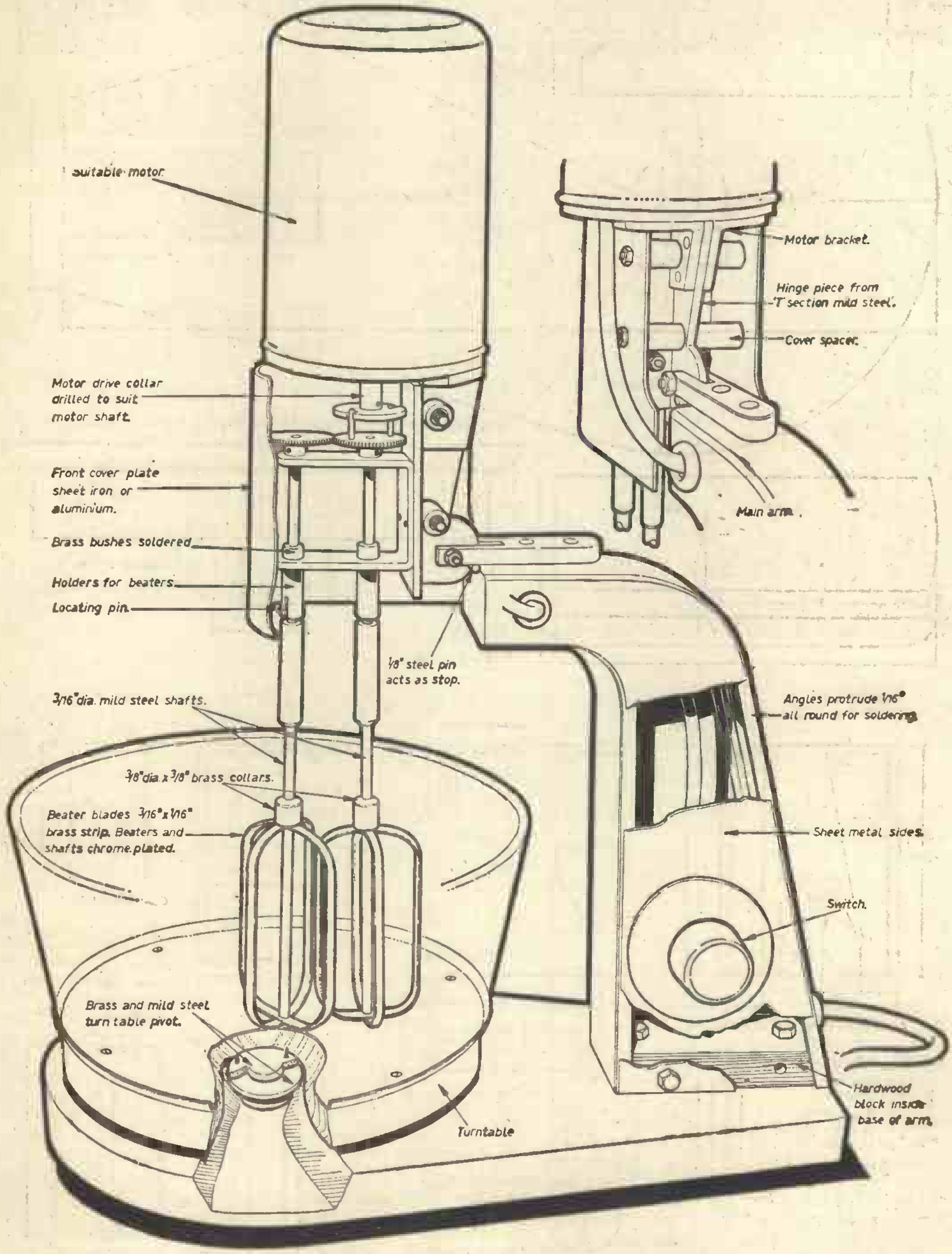
This is cut from the same thickness wood as the base board ⅞in., dia. is 6in. Next turn the pivot and drill three ⅛in. holes and countersink to take wood screws. Screw this to the bottom of the turntable. Mark a 1¼in. dia. circle on the underside to locate the pivot. Before screwing it on make sure it is a nice running fit in the brass bush. Next is the plate to hold the mixing dish in position. This is made from aluminium and is easy to work. Brass or sheet metal are also suitable. A jig for forming the edge on the plate is shown in Fig. 1. Make your disc ½in. bigger than your turntable for the turn up. Drill a hole in the centre of the disc and bolt it to the jig. Place the jig in the vice allowing the sheet to turn freely, and form bend with a light hammer. Drill four ⅛in. dia. holes for wood screws, countersink them and screw the disc to the turntable, clean the top edge with a smooth file.

Main Arm

The *main arm* is made from sheet iron and requires two arms and two 1in. strips to fit front and back (see drawing Fig. 2). These are cut with tin snips. The right-hand side arm from the front of the mixer has the grommet and hole for the on/off switch. The other side has no fittings. Drill the grommet hole in the side arm and in the back 1in. strip. The length of the 1in. strips is decided by bending them round the side arms, leave them ¼in. longer and trim later when the job has been soldered up. Take your ¼in. x ¼in. x $\frac{1}{16}$in. brass angle and bend *two* to the inside and *two* to the back of the *side arms* leaving them $\frac{1}{16}$in. over as shown in Fig. 2. See that the angles and side pieces are level, lay two angles down right way on a piece of wood. *One inside angle* and *one* back angle. Lay the *right-hand* side arm on these angles leaving $\frac{1}{16}$in. of the angles showing all round, see drawing, Fig. 2. Clean your sheet iron side arms and angles before soldering. Use Spirits of Salts for the soldering. It is important to fix the on/off switch before you assemble the whole arm otherwise it is difficult to get in. The front 1in. strip is soldered next then the back. Trim off surplus 1in. strip and clean up all round with a smooth file.

Hinge Piece

The next item is the hinge piece for the main arm, see drawing Fig. 3. Slot one end for the other



Perspective view of construction.

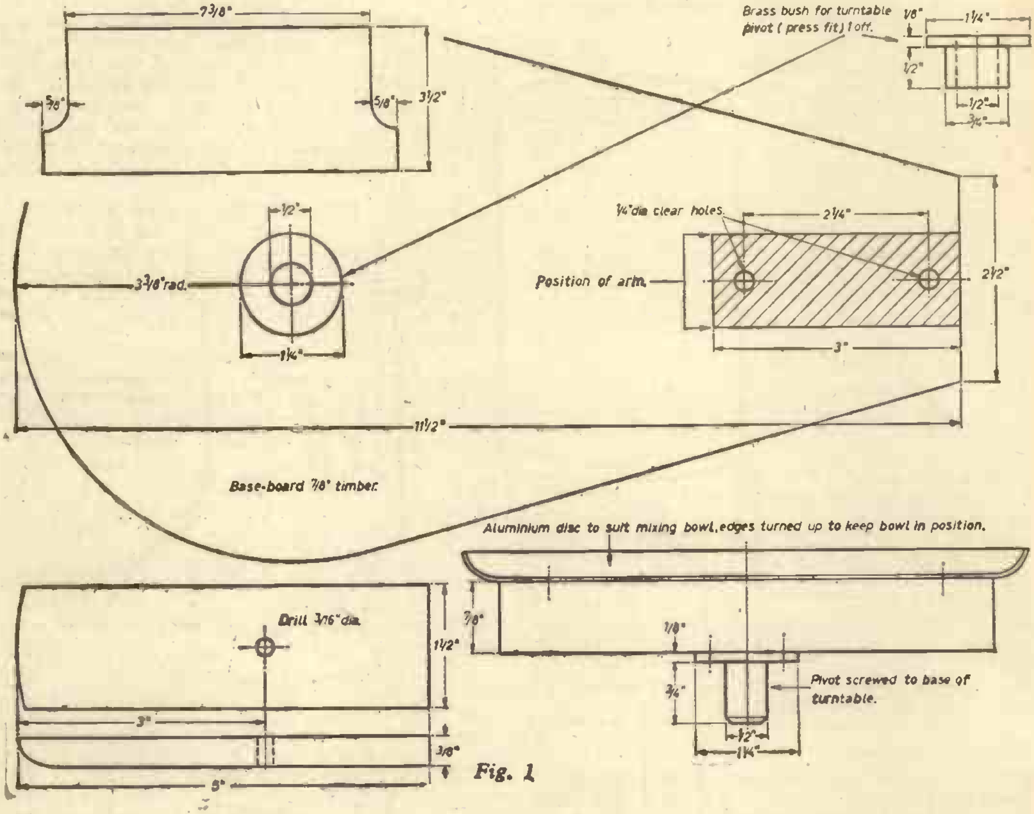


Fig. 1

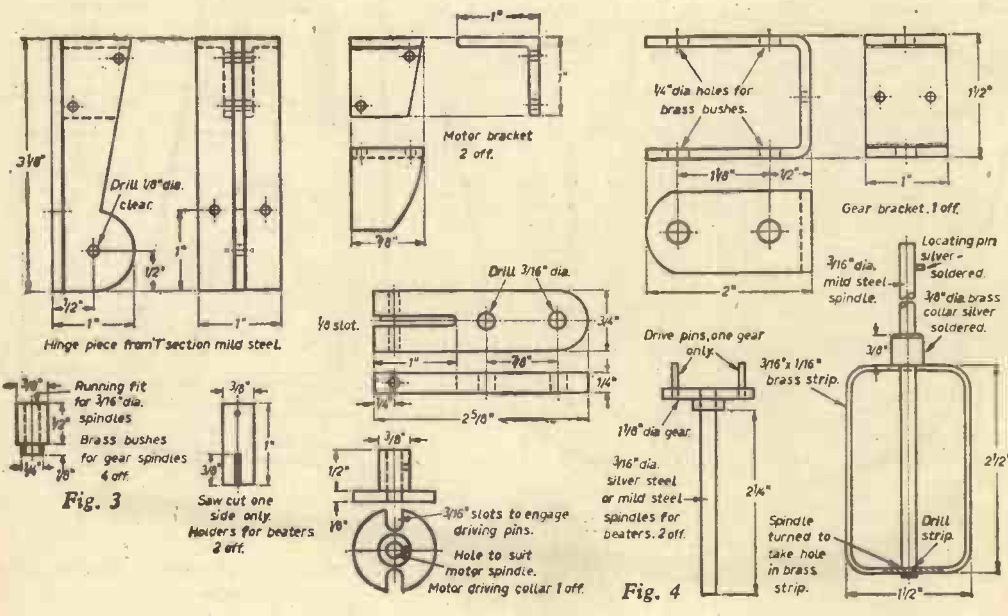


Fig. 3

Fig. 4

hinge piece and round the other end for neat appearance. This can be bolted or riveted on to the arm.

Next make the other hinge piece that carries the motor and beater gear bracket. This can be made in "T" section, steel or brass or alternatively two pieces of ½in. x 1in. x ⅛in. angle. Drill and rivet them together, countersink the holes to give the rivets a flush fit. Mark out and cut to shape. See drawing. Next cut the pieces of same size angle for mounting the motor, drill and rivet them in position, leave the holes in the top of the angles that holds the motor till later. This hinge part is now bolted to the other one on the arm. Hold it in the upright position and drill the hole for the pin. To stop it falling forward from the upright a ⅛in. pin is inserted to act as a stop, see drawing.

Bracket for Mounting Gears

This is made from 1in. x ⅛in. brass strip bent to the shape shown in the drawing. Mark off and drill the holes. Having turned the bushes put them in the holes then insert two pieces of material the same dia. as the spindles, 3/16in. rod and solder the front bushes to the bracket. Try the spindles with the gears on before you solder the back bushes to make sure the gears run smoothly. A piece of brown paper between the gear teeth will give the right clearance when soldering the lot together. The collars that hold the beaters can now be pushed on and screwed up tight leaving a little end play so that the gears run smoothly. Leave the drilling in the back of the gear bracket until you have fixed the motor and its driving collar. You will have a better idea where the holes are to come.

Motor Drive Collar

Turn up from brass the motor drive collar. Put a small grub screw for fixing to the motor shaft, drill and cut the slots, see drawing. The idea of the slots for a drive is for easy alignment of the motor to the gears.

Fit the motor drive collar on and hold the gear bracket in position. Try the motor for the right location and mark gear bracket fixing holes, drill and assemble.

Cover Plate

The cover plate for the gears is a simple job, see drawing. This can be cut from sheet iron or aluminium. Bend this round a piece of 1¼in. dia. material. I cannot give measurements for drilling. If the gears used are a shade bigger in dia. this means the cover plate will come forward a bit. Bolt it through the back of the arm that carries the beater bracket. Use screwed rod with a nut on both ends with pieces of small tubing as distance pieces.

Now wire up to the motor and solder a 1in. x 1in. cover plate on the end of the arm section. Insert the wooden block in the bottom of the arm and screw down to the base. Then bolt the arm to the base.

The Beaters

For these you require four strips of brass 3/16in. wide by 1/16in. thickness and about 7in. long, mark the centre with a centre punch, bend to shape and cut off surplus where they enter the collar. Drill the holes to receive the end of the beater rod. Two collars are made from ¾in. brass rod and drilled with 3/16in. centre hole. The beater rods are two lengths of 3/16in. mild steel rod 6in. long, turn one end of both to form a shoulder to receive the brass strips. See drawing Fig. 4, and rivet them over. Slip the collars over the other end and solder in position. To determine the length of the beater leave them ½in. clear of the bottom of the mixing bowl.

Having cut them to length try them in the beater holders. Push them right home and mark for the hole for the locating pin. Make sure the beaters are in the right position and that they clear one another as they revolve, drill the hole for the small pin and drive them into a tight fit. If possible have these chromium plated.

The author used a government surplus low voltage motor operating through a transformer, but as this may not suit individual requirements, we would suggest you use one of the fractional H.P. motors made by Hoover Ltd., Perivale, Middlesex. The minimum rating to operate this machine should be 1/8 H.P. approx. 100W.

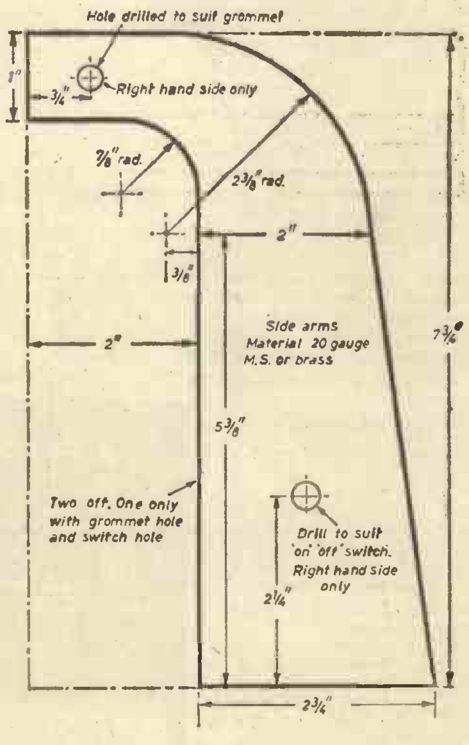


Fig. 2

Plan of Main Arm showing correct shape and hole positions.

Accessories for Sub-miniature Photography

By A. E. BENSUSAN

ALTHOUGH many sub-miniature cameras are fitted to take cable releases, and have shutters permitting a "bulb" setting, few have any tripod bushes or other means of clamping down firmly while giving lengthy time exposures. The cradle shown alongside a sub-miniature camera in Fig. 1 offers a solution to this problem. It grips the camera reasonably tightly and has a suitably threaded receptacle to allow it to be mounted on a standard tripod head.

As drawn in Fig. 2 the cradle consists of a fairly rigid support, cut out if necessary for the film numbering window to be seen and its slide cover to be operated. A semi-circular notch at the top clears the eyepiece of the viewfinder. The base of the support is bent over at right-angles and all sharp edges are removed.

The material is brass or half-hard aluminium alloy of approximately 20s.w.g., or a slightly thicker plastic such as polystyrene could be employed. In that case the angular section should be formed by joining two separate flat parts together with the appropriate cement, available in sixpenny tubes for plastic model making.

The clip is 22s.w.g. spring steel, although thin plastic could be used here, too. The shape is not very important provided that the camera can be sprung in and out easily and without risk of damage. The slight bends at the tops of the lugs hold the camera down firmly, while the central cut-out locates the camera lens barrel against sideways movement. The dimensions given in the drawing are for the Mycro camera and would need adjustment for other models.

If plastic is used for the support and clip they can be cemented together in the appropriate relationship. Metal components require the use of an epoxy resin such as Araldite for assembly and, in any case, that is necessary to secure a $\frac{1}{4}$in. Whitworth nut to the centre of the unit.

The processing of sub-miniature films always presents considerable difficulties because the films are so narrow, although often only 6 or 7in. long. In some gauges special developing tanks are available but at prices almost as high as those of the cameras themselves; in others no tanks can be bought. The writer has found that a simple fitment can be made from scrap 35mm film to enable sub-miniature films to be developed in a standard tank and this is shown in Fig. 3.

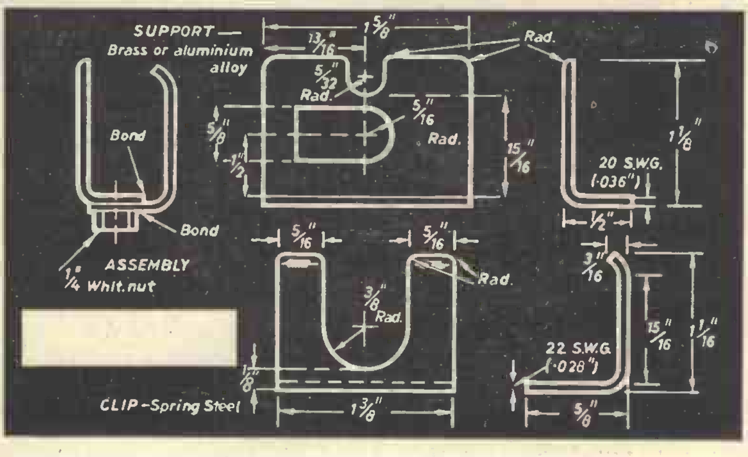


Fig. 2.—Tripod cradle.

A strip of 35mm film at least 1in. longer than the sub-miniature film has a slot cut in it ½in. shorter than the sub-miniature film and slightly narrower. At each end a short piece of 35mm stock is stapled to the modified strip, using plated miniature staples, so that the inner edge of the addition coincides with the end of the slot in the long strip. At a distance of, say, ¼in. from this coincidence another staple is put transversely to act as a stop and, beyond that, yet another to help spread the load. The result is a cut-out holder with a ¼in. deep pocket at each end.

In the dark each end of the sub-miniature film is tucked into a pocket so that its emulsion side is outwards. It is then firmly retained over the slot and the adapted 35mm film is loaded into the tank in the usual way for processing to be carried out. If required, three or four of these adaptations can be stapled together to allow a number of sub-miniature films to be processed at one time.

The leading and trailing ⅜in. or so of each film is not normally exposed in the camera and the fact that those parts are enclosed in pockets which prevent chemical solution access is unimportant. The films can be taken from the tanks and hung up in the adaptations to dry before filing.

Since the films are so small they should be filed away before they have had an opportunity to pick up dust after drying. Fig. 4 shows a useful home-made file holding six strips of film, each in a separate translucent sleeve. Tracing or other suitable paper is cut to a width about three times that of the film. A strip of cardboard, shown at the top of Fig. 4, acts as a former around which the sleeves are automatically folded to the correct width, which is that of the film plus about ⅛in. for easy insertion and withdrawal. A line of glue secures the overlap of each sleeve.

The film reference number is entered on the end of each strip and the appropriate frame numbers along one edge, using black indian ink and a mapping pen. The empty sleeves are not sealed at either end but are stapled at one end in sets six deep into a folded cardboard cover which is closed with a rubber band. The file is then ready for use.

Unless a special sub-miniature enlarger is bought, at an astronomical price, a standard enlarger has to be employed. This means that either a special film carrier must be made or an adaptor constructed to fit the existing one. Fig. 5 shows a special carrier made from very thin aluminium alloy with a cut-out to suit the frame size. Two strips of card cemented to the top face serve to guide the film accurately across the aperture.

This type of carrier is suitable for enlargers where the condenser is lowered on to the film and holds it flat. The normal carrier is dispensed with but thin packing strips may be needed to be cemented to the underside of the new carrier if the vertical travel of the enlarger condenser mount is otherwise insufficient.

An alternative arrangement is shown in Fig. 6 but is only suitable if there is adequate height in the enlarger negative stage. Two thin optically flat glasses from a slide mount are hinged together at one edge with tape and a thin metal location and aperture strip slipped between or below them. The existing carrier is retained and the adaptor placed on top. The location strip seats between the guide pins for the larger film and has bent-over ends to prevent lengthways movement.

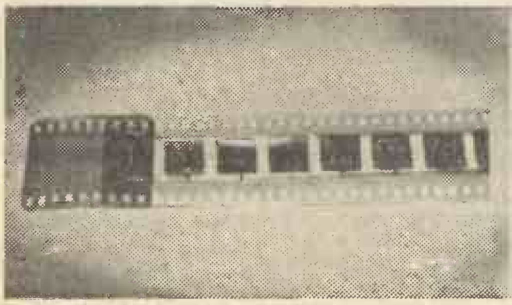


Fig. 3.—Processing adaptor.

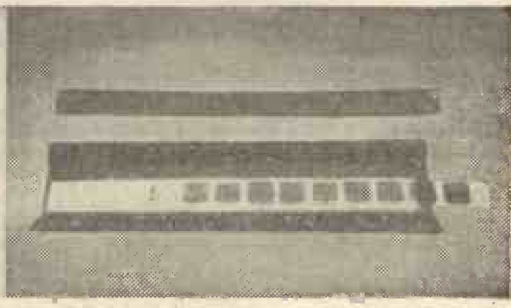


Fig. 4.—Sleeve former and negative file.

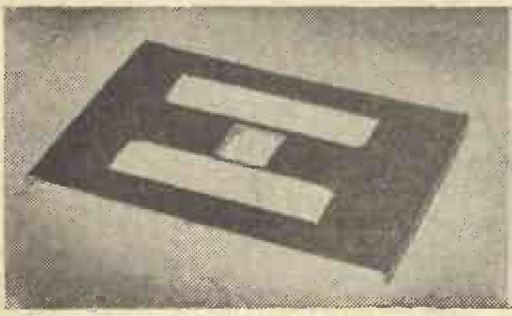


Fig. 5.—Glassless enlarger carrier.

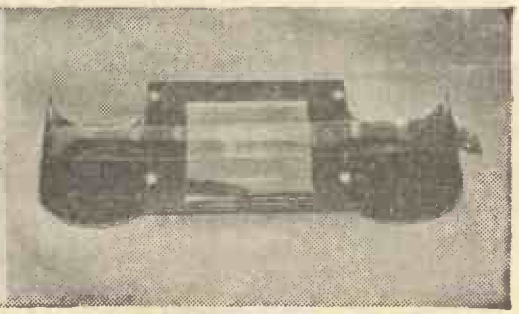


Fig. 6.—Glass enlarger carrier adaptor.

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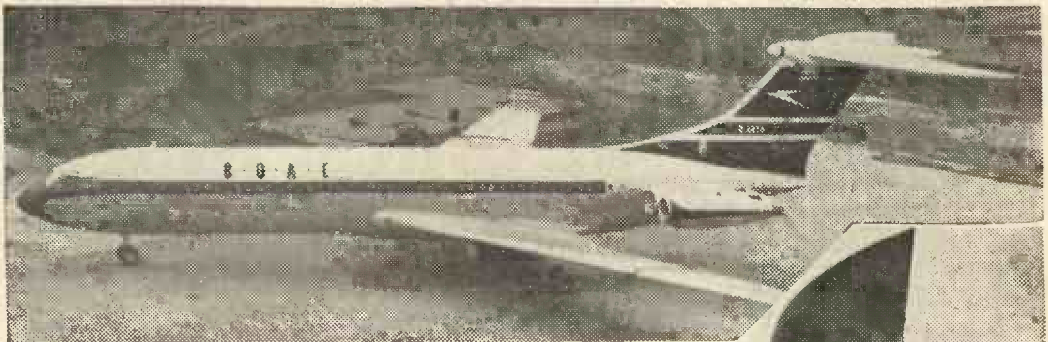
PICTURE NEWS

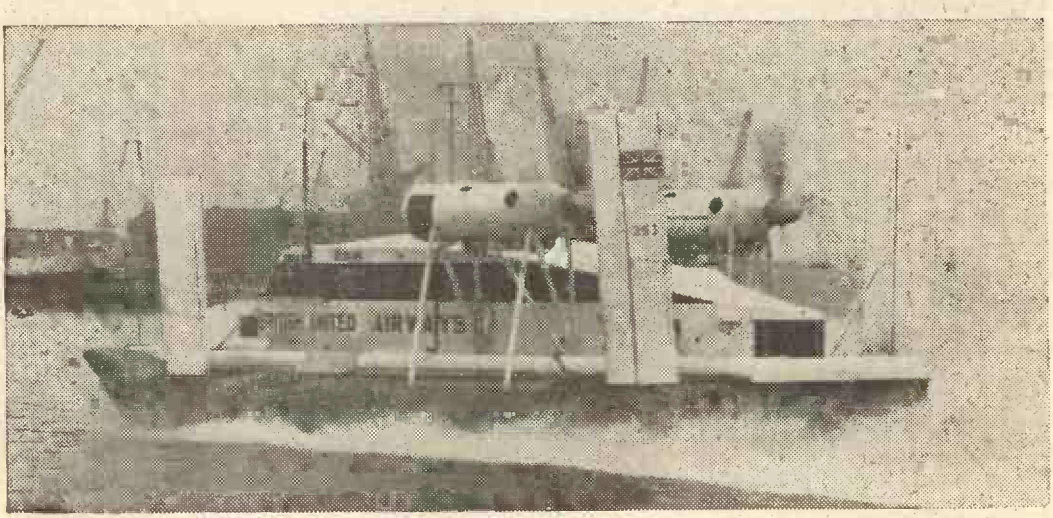
FROM THE WORLD OF SCIENCE



The most powerful airliner in the world, the Vickers VC.10. Four rear mounted Rolls Royce engines will give the plane a cruising speed of 600 mph. It is 158ft. long and weighs 150 tons.

A close up of the high mounted tailplane which has a span 8ft. greater than that of a Spitfire.

The Royal Navy's guided missile destroyer, H.M.S. Devonshire, during firing trials of the ship-to-air medium range guided weapon SEASLUG. The weapon is lethal against any maritime strike aircraft.



The Man-Powered Helicopter called a "Cyclopter" which flew an inch above the floor at the Air Ministry in London. The "Cyclopter" was designed and built by W/O Spencer Bailey, aged 48, who is stationed at Melksham, Wilts., at a cost of £45 and 400 hours of his spare time.

The largest and first practical commercial Hovercraft, the Westland SR.N.2, was demonstrated on the Solent at East Cowes, recently. The Hovercraft is capable of travelling at 90 mph over calm water on a 12-inch high cushion of air and it is hoped that the craft will be operational on an experimental run between Southampton and the Isle of Wight before the end of the summer.

PHOTOGRAPH RIGHT SHOWS:—A visitor to the Hovercraft sampling the comfort of the Westland SR.N.2's passenger compartment.

PHOTOGRAPH LEFT:—It was announced recently that British United Airways are operating the Vickers VA-3 on the world's first scheduled Hovercraft Service this summer, across the Dee Estuary between Hoylake in Wirral and Rhyl on the North Wales Coast. The VA-3 is primarily intended for coastal operations. It weighs 11 tons is powered by four Blackburn 603 Turmo Gas Turbines. Two of these engines provide the lift and the other two mounted at the rear provide the propulsion.

Direction Finding Receiver

by E. V. King

THIS is a small, powerful superhet receiver with B.F.O. provision which will operate on the international Radio Beacon band 285 to 315kc/s and on ordinary medium wave broadcasting stations. The Radio Beacon (R.B.) range is used mainly for direction finding, the Broadcast (M.W.) range for entertainment and less accurate direction finding.

The D.F. set will be useful for all small boat owners, hikers, Scouts and school exploring expeditions.

Construction requires some knowledge of radio and soldering. No refinements have been added other than the B.F.O. in order to keep the cost down.

Constructing the Receiver

Readers without any radio knowledge should not attempt the construction. Please consult the parts list for values, sizes, etc. Do not use substitute parts, use exactly those stated.

Mounting the Components

The tag strip is prepared as in Fig. 3, some holes are already present, the others have to be drilled. The components are now mounted, leaving the variable condenser until last and keeping its vanes closed all the time. VR1 is mounted as in Fig. 4a and done up tight; it is seen to the left of Fig. 5.

S1/S2 (four-pole two-way in prototype) is similarly mounted and is orientated *carefully* as in Fig. 8a.

The I.F. transformers and coils are next fitted. These are colour coded as in Fig. 9 and are mounted as in Fig. 8a, taking care to get the lettering to correspond with the theoretical circuit. The I.F. mounting procedure is shown in Fig. 4b, one solder tag having to be fitted as shown. The I.F. cans can be seen in Figs. 5, 7 and 12. Orientation of these is of utmost importance. Check with Figs. 8 and 3.

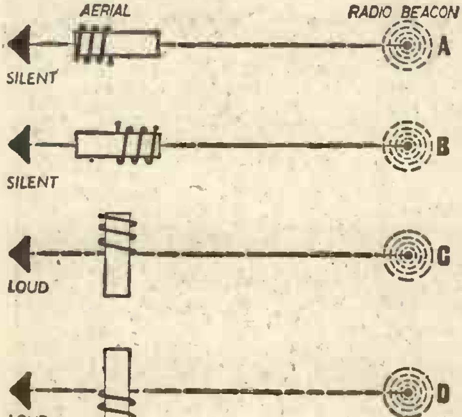


Fig. 1.

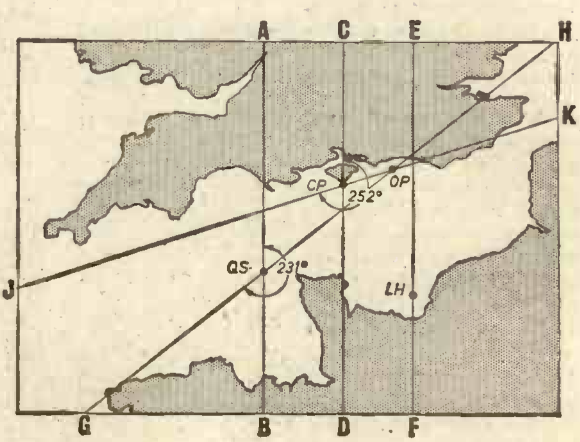
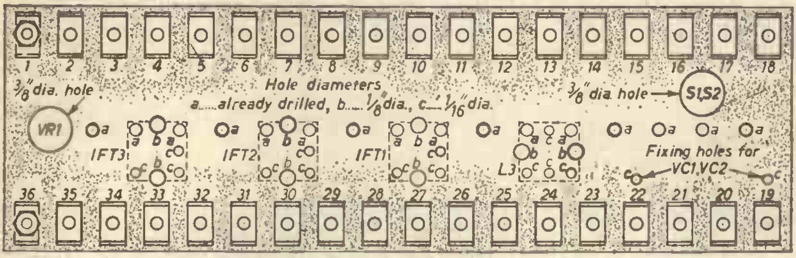
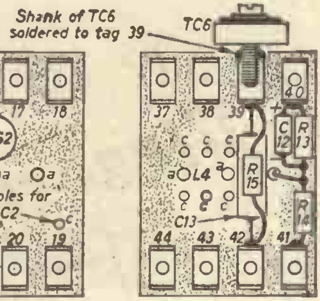


Fig. 2.

Fig. 3a and 3b.





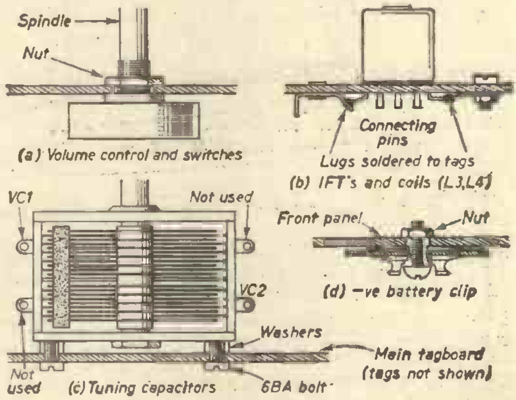


Fig. 4.

PARTS REQUIRED

RESISTORS (all ½ w. 10%)

R1	10k	R6	1k	R11	15k
R2	56k	R7	33k	R12	680 ohms
R3	1k	R8	4.7k	R13	10k
R4	68k	R9	1k	R14	68k
R5	10k	R10	68k	R15	1k

CONDENSERS

VC1 & VC2 a Jackson 00 gang with trimmers and screen.
VC1 = 208pf and VC2 = 176pf.
TC1 already fitted to VC1 by makers 60pF.
TC2 already fitted to VC2 by makers 60pF.
TC3 Trimmer 250pF max.
TC4 Trimmer 250 pF max.
TC5 Trimmer 250 pF. max.

C1 1.0 mfd. Min. Electrolytic, 12 or 25v.
C2 .01 Mfd. paper.
C3 250pF mica 5% or better.
C4, 5, 6 & 7 all 1.0 Mfd. min. electrolytics, 12 or 25v.

C8 50 mfd. electrolytic 12 or 25v.
C9 25 mfd., electrolytic 12 or 25v.
C10 0.01 mfd. Paper.
C11 100mfd. electrolytic, 12 or 25v.
C12 1.0 mfd. Min. Electrolytic 12 or 25v.
C13 0.01 mfd. paper.
C14 500pF mica., 5% or better.

TRANSISTORS, as used on prototype
1. Mazda XA131, alternative OC44.
2. Goldtop V6/R2, alternative OC45.
3. Goldtop V6/R2, alternative OC45.
4. Mullard OC71.
5. Mullard OC44.

Diode OA81.

TRANSFORMERS AND COILS

Ferrite slab aerial. Repanco FS 39.
Oscillator coils (L3, 4 and 5) all in one can. Repanco X028.
I.F. Transformers:
1. XA26 (Repanco)
2. XA26 (Repanco)
3. XA27 (Repanco)

Messrs. Repanco, c/o Radio Experimental Products Ltd., Much Park Street, Coventry.

SWITCHES

S1/S2 4 pole, 2w in the prototype, 2 pole, 2w will suit.
S5 1 pole, 1 way toggle.
S3/S4/VR1 A 10k vol. control with double pole switch.

OTHER NECESSARY PARTS

Battery, Siemens TR4 and tags from an old battery.
B.F.O. coil (L6, 7, 8). One unit, Repanco XT27.
Tag strips. Two boards, standard size 2 x 6½, 36 tags.
Phone socket. Bulgin J2.
Phone plug. Bulgin P.38 to fit above.
6 B.A. nuts, bolts, solder tags, fine copper P.V.C. covered connecting wire, cored solder, and some soft wood, handles, etc.
Compass. See text for full details.
Phones. Surplus, low resistance type, D.L.R.5.

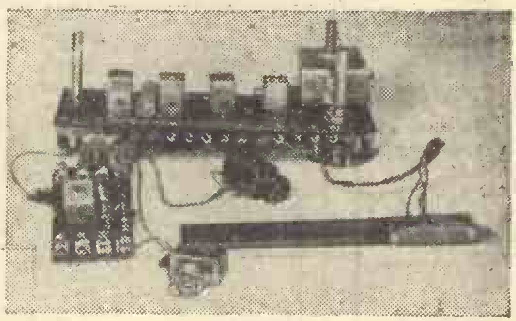


Fig. 5.

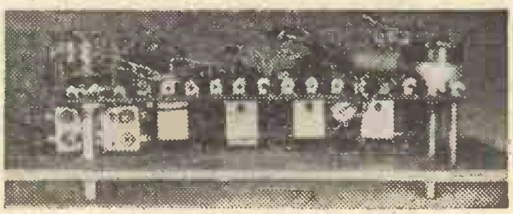


Fig. 6.

The three trimmers, TC2, TC3 and TC5, are mounted as in Fig. 8 by bending the outside tags of the tag board and soldering the brass-threaded portion of the trimmers to the tags.

The tuning condenser is mounted as in Figs. 5 and 7 by the method shown in Fig. 4c, noting

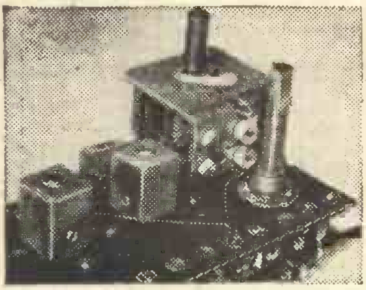


Fig. 7.

that washers are necessary to give firm mounting. The holes are already tapped for B.A. screws.

Wiring the Unit

There is not space in this article for point-to-point wiring details. Readers should wire as far as possible from Fig. 10. Cored solder only must be used or failure will be assured. Leave the transistors out until last.

The resistor values are very important.

Resistor Coding Chart

R1.—Brown, Black, Orange, Silver.
R2.—Green, Blue, Orange, Silver.
R3.—Brown, Black, Red, Silver.
R4.—Blue, Grey, Orange, Silver.
R5.—Brown, Black, Orange, Silver.
R6.—Brown, Black, Red, Silver.
R7.—Orange, Orange, Orange, Silver.
R8.—Yellow, Violet, Red, Silver.
R9.—Brown, Black, Red, Silver.
R10.—Blue, Grey, Orange, Silver.
R11.—Brown, Green, Orange, Silver.
R12.—Blue, Grey, Brown. Silver.
R13.—Brown, Black, Orange.
R14.—Blue, Grey, Orange.
R15.—Brown, Black, Red.

Each resistor is shortened and the leads bent to the required shape before it is soldered in position. The condensers are individually marked, sometimes different units are used, and the following may help:

Condenser Chart

Common Marking.	Less Common Markings.
208pF.	0·000208 Mfd.
176pF.	0·000176 Mfd.
750pF.	0·00075 Mfd.
·01 Mfd.	10,000 pF.
250pF.	0·00025 Mfd.
500pF.	0·0005 Mfd.
1 Mfd.	1,000,000 pF.

The condensers are soldered in position, especially watching that the electrolytic condensers are not heated too much and are fitted the correct way round. This will be shown by plus and minus markings or red and black ends respectively. Where wires are directly connecting components or tags they should be as short as possible, well insulated and soldered at the ends without "whiskers" protruding. Care is required to identify the trimmers, to wire them correctly and to connect the centre screwed part of each to tag 14 (this takes the place of chassis or earth). Correct identification of the wiring to the switch S1/S2 is necessary, the aerial coil wires being identified by colour spots as in Fig. 8. The small, compact long-wave aerial coil seen removed in Fig. 16 is not required.

Fig. 8b.

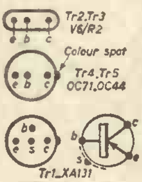


Fig. 9.

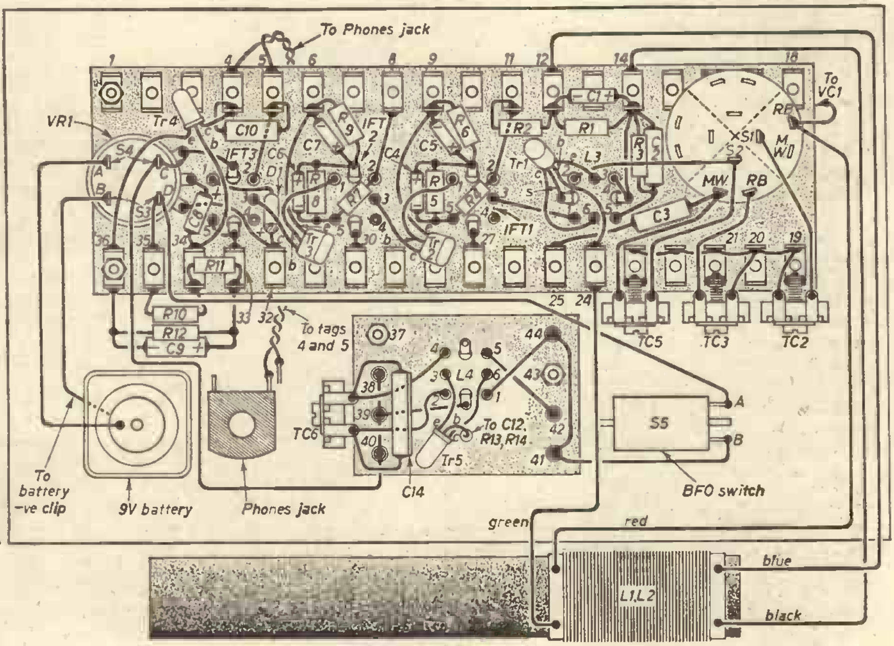


Fig. 8a.

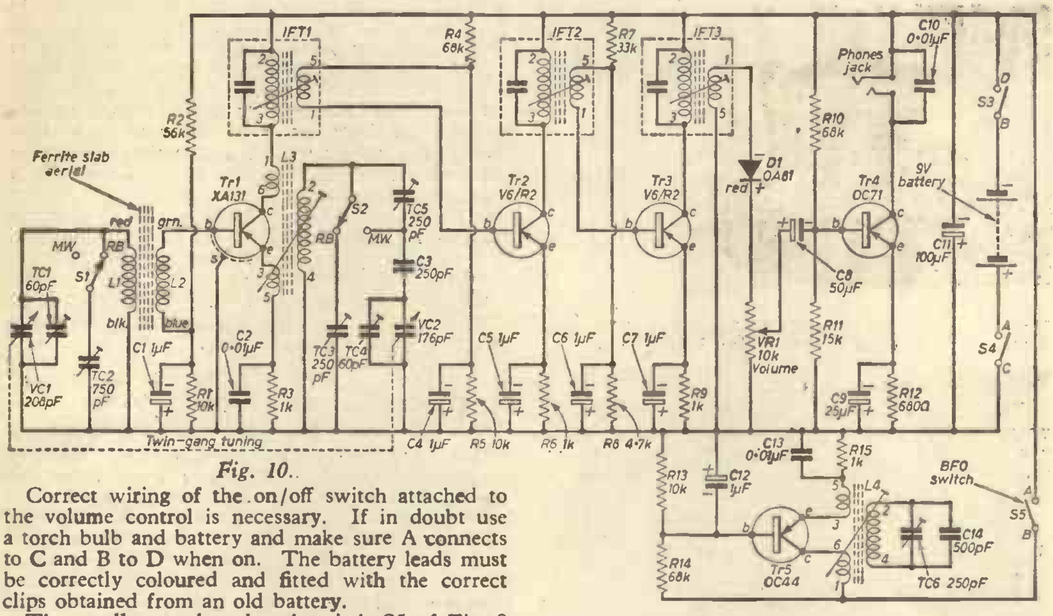


Fig. 10.

Correct wiring of the on/off switch attached to the volume control is necessary. If in doubt use a torch bulb and battery and make sure A connects to C and B to D when on. The battery leads must be correctly coloured and fitted with the correct clips obtained from an old battery.

The smaller tag board and switch S5 of Fig. 8 are *not yet* added. The transistors are now identified, the connections are identified as in Fig. 8b, sleeving is slipped over the leads and they are quickly soldered in place, taking care not to let the hot iron warm up the transistor body. The "M" lead of the XA131 is taken to earth via the casing of the X028 coil and tag 14. The main tag board now looks as in Figs. 6 and 14. If an OC44 is used instead of XAB1 no earth connection is necessary.

The vanes of the condenser (VC1 and VC2) nearest to the tag board are VC2 and those farthest away are VC1. The earthing tag on the back of the condenser goes to tag 14 (see Fig. 7). The trimmers TC4 and TC1 are seen respectively on the variable condenser just behind the switch control spindle.

Testing the Receiver

Phones are connected to tags 4 and 5 or to the jack. DLR5s are cheap and work best in this unit, but miniature deaf-aid types will also suit (by-pass tags 4 and 5 with a resistor of value about 1k and use a crystal earpiece). Connect the battery leads correctly to a PP4 9V transistor battery. Put the wave-change switch to broadcast (M.W.), turn the volume control up fully and pick up the local broadcast station. Now slide the coil along the ferrite rod aerial to get the loudest reception and temporarily fix with a small strip of Cellotape. Now try and find a very weak station, failing that turn down the volume on the local one.

Peaking the I.F. Transformers

With the weakest signal you can hear very carefully and slowly try turning the core of I.F.T.1 a turn or so either way. Set it the position of most volume. DO NOT TOUCH THE TUNING CONDENSER. Turn the volume down if necessary. Now peak up I.F.T. 2 and 3 similarly.

Setting the Core of X028

In the event of no signal being received during the above procedure the core may need adjustment (usually in). Now set TC4 and TC1 (on the variable condenser Fig. 7) one turn each from being done up tight. By very slight adjustment of the core of the X028 coil full medium wave coverage from Luxembourg to, say, Athlone should be obtained. It will be necessary to peak up carefully in this manner:

1. When the vanes are in adjust the coil on the ferrite rod for best reception.
2. When the vanes are almost out adjust TC4 and TC1 for best results.
3. Repeat 1 and 2 two or three times.

The receiver will now receive all medium wave stations normally received by any superhet receiver. The aerial is directional and fading may occur as no A.V.C. is required for D.F. work. The aerial coil (on the ferrite rod) may now be fixed more securely with Cellotape.

The D.F. Beacon Band

Once the medium wave broadcast band has been set the coil on the ferrite rod, trimmers TC4 and TC1 and all the cores must not be touched. Set TC5 half way in.

Switch to Radio Beacon band. Swing the tuning condenser, endeavouring to pick up a beacon. Adjust TC2 and TC3 (trimmers) while swinging the condenser vanes until a beacon is heard. This must now be identified by listening and noting the slow Morse call letters. Reference to one of the Admiralty charts will give the station and its frequency. If no beacon can be obtained fit the B.F.O. unit (described later).

When the vanes are fully open aim at receiving on 285kc/s and when fully in at 315kc/s and pro rata. If the vanes are too far in for this undo TC2 and TC3 a little and retune the beacon as necessary. Or reverse this procedure.

(To be continued)

TELLING THE TIME

By SCHOOLMASTER

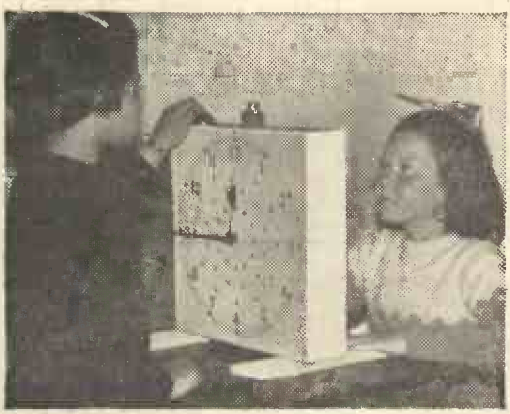
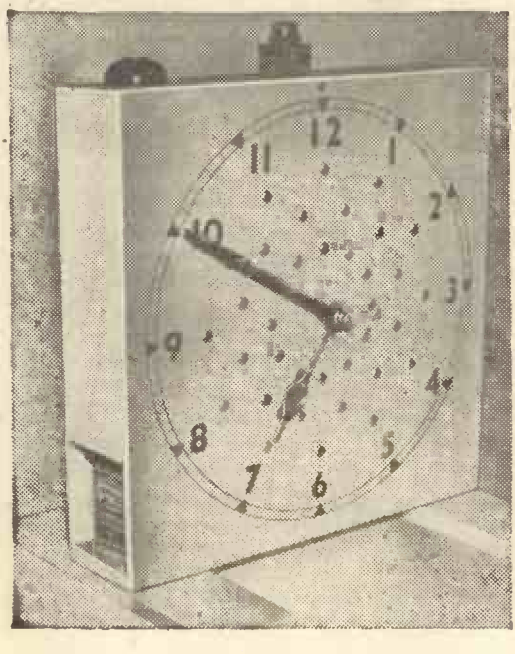


Fig. 1.—A child sits on either side.

Fig. 5.—Showing battery position.



CHILDREN nowadays have watches given to them at an earlier age than in the past. An instructive game to enable them to learn to tell the time can be constructed for use in the home or school. Fig. 1 shows how this is done. A child sits on either side of the clock which has an identical clock face on both back and front. One youngster sets the hands to a time and informs the other to set her clock hands to such-and-such a time. The second child sets the clock hands on her side to the given time. If she is correct then on pressing the push button on the box top the bulb in the centre of the top will light up. If the child is wrong then nothing happens.

The clock described here will enable the child to learn the time, to within five minute intervals, in an amusing yet instructive way.

Box Construction

The sides are of 3in. x ½in. cross-section and the back and front are made from 14in. square pieces of hardboard. The feet are made from the same material as used for the sides.

The brass headed pins used for contacts are at a radius of 2in., 3in. and 4in. These radii need not be strictly adhered to. The first circle of studs gives the hours, the second circle the half hour positions and the outside circle gives the five minute intervals.

The minute interval ring is inked on by compasses and the figures stencilled. The contact pins are hammered flat in the inside to prevent movement and are then connected to the corresponding contacts on the other panel by insulated copper wire which is soldered into position. It is best to connect the back and front panels first and then complete the box afterwards otherwise it will be difficult to carry out this operation.

Electrical Circuit

The electrical circuit showing one complete circuit for one position of the hands is given in Fig. 2. If the hands are moved to any other position then of course the same type of circuit applies. The hands are really used as switches and are made from ¼in. x 16 gauge sheet metal. The stronger the better in order to stand up to rough usage.

In place of the light an electrical toy can be used. Anything in fact which will give satisfaction to the child.

Stud Contacts

The contacts between the hands and the studs can be of two different designs as shown in Fig. 3(a) and (b). I've used both types of contacts for a long time and the choice is therefore a personal one. Fig. 3(a) is a spring loaded contact which is, to a certain extent, self-adjustable under working conditions. Whereas the contact shown in Fig. 3(b) is a rigid one and is not self-adjusting under working conditions. It however stands up to greater wear and tear. There are of course two contact studs on the hour hand and one on the minute hand. Care should be taken to make sure that the point of the hour hand does not foul the contact stud of the minute hand.

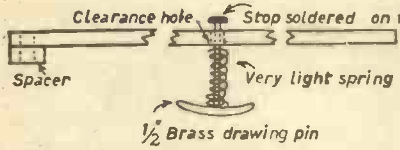


Fig. 3a.

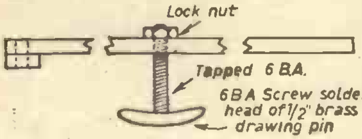


Fig. 3b.

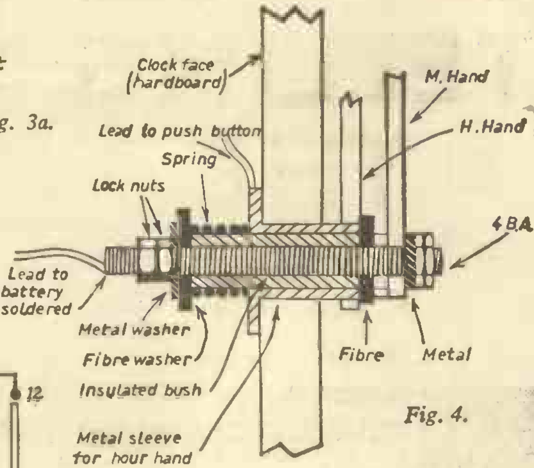


Fig. 4.

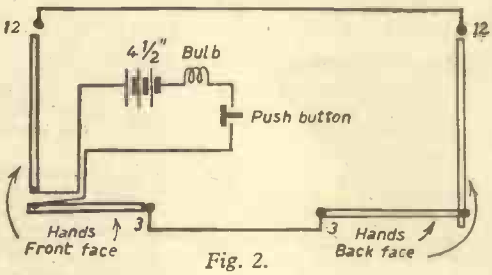


Fig. 2.

Constructional details.

Clock Hands Switch

In order to have a complete electrical circuit as in Fig. 2, then one set of hands must be electrically separated in order to make a switch. The other set of hands can be in hard contact and bolted together through the side of the case. Each hand is soldered on to a spacer in order to give increased rigidity when mounted on the clock face.

The set of hands requiring to be electrically separated is easily accomplished as shown in Fig. 4.

Battery Compartment

Only two items require replacement. The bulb, by unscrewing the protective coloured cover, and the battery. The battery is housed in a compartment at the base of an end panel. By removing part of the panel which acts as a cover the battery is exposed as shown in Fig. 5. The battery is of the 4½V flat torch type, held in place by spring contacts.

FLIGHT RATING ON ROCKET ENGINE by Donald S. Fraser

THE United States' first liquid rocket engine has successfully completed its preliminary flight rating test, the National Aeronautics and Space Administration has just announced. The engine, the RL-10, was designed and developed for NASA's Marshall Space Flight Centre by Pratt and Whitney Division of United Aircraft Corporation at its West Palm Beach, Florida, plant.

This test marks a significant milestone in the development of the engine, whose performance is about 30 per cent better than current rocket engines using conventional hydrocarbon fuel such as kerosene. This makes possible greater payloads or longer range for U.S. launch vehicles.

Two RL-10s will power the Centaur space vehicle, scheduled for its first flight in the next few months. Later, six RL-10s will be clustered to power the second (S-1V) stage of the Saturn vehicle.

The test, consisting of 20 captive firings, was completed in five days. All firings were accomplished with the engine under simulated space conditions. Throughout the test the engine consistently produced its rated 15,000 pounds of thrust.

Inspection, following the firings, indicated the engine was still in condition for continued firing and further testing.

Development of the RL-10—previously known as the XLR-115—was started in October, 1958. During the development programme the RL-10 completed over 700 firings for an accumulated firing time in excess of 60,000 seconds. The programme recently accelerated to about 70 firings a month.

Pratt and Whitney has delivered a total of 12 engines to the High Thrust Test Area, Edwards, California, to the NASA Lewis Research Centre, Cleveland, Ohio, and to General Dynamics/Astronautics and Douglas Aircraft Company for further testing prior to launching of the Centaur and Saturn space vehicles from Cape Canaveral.

Fueled by liquid hydrogen, whose boiling point is −423deg. F., the engine is designed to provide a capability of multiple restarts in space with coast periods of many hours between firings.

The engine uses a regenerative or "bootstrap" cycle to pump and burn hydrogen. The fuel drives the pump system and also cools the thrust chamber. The hydrogen, sparked by an electrical igniter, burns with liquid oxygen inside the thrust chamber.

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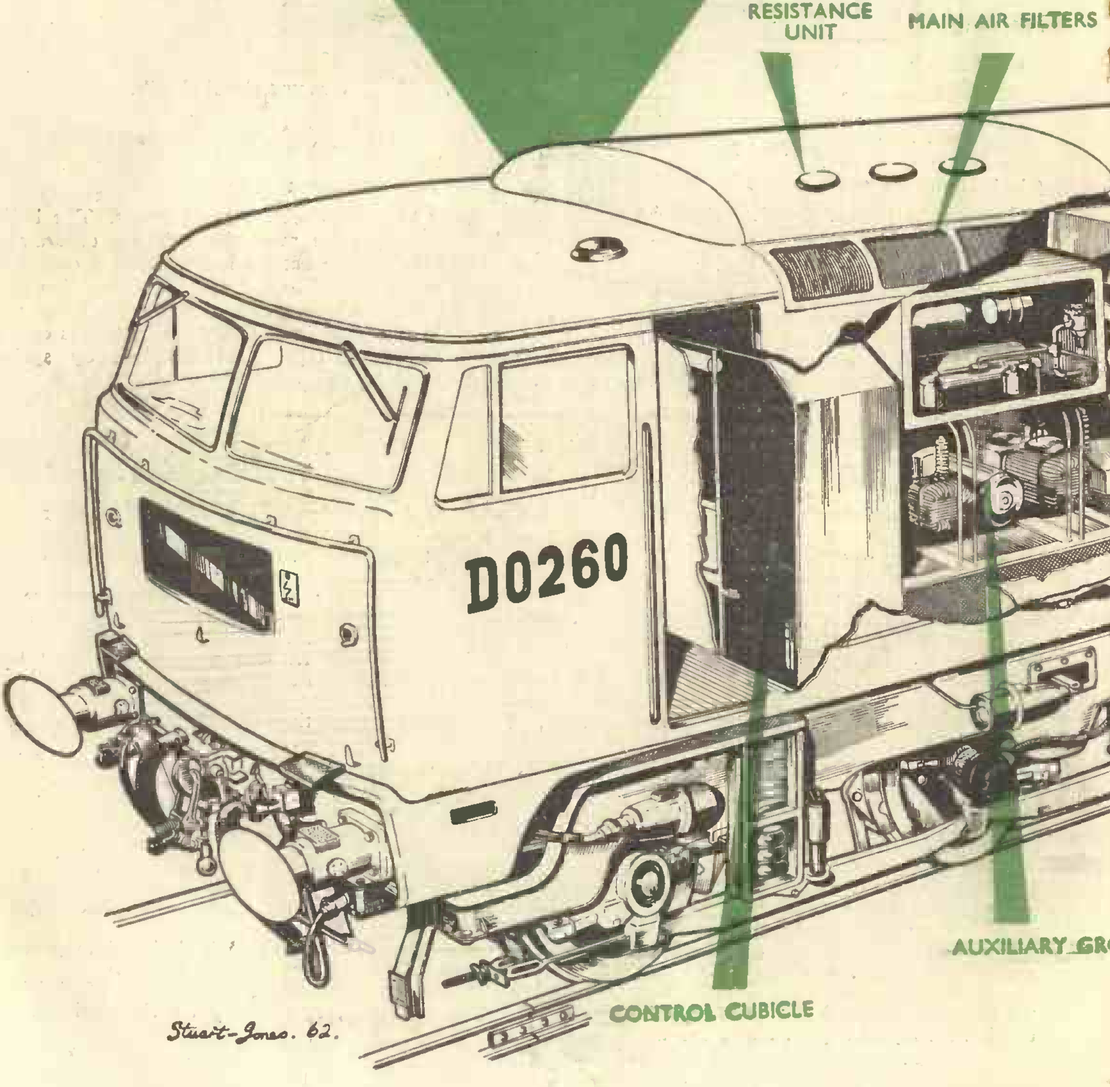
LION

ASSOCIATED ELECTRICAL INDUSTRIES — SULZER — BIRMINGHAM RLY. CARRIAGE & WAGON Co.

BRITAIN'S LATEST DIESEL ELECTRIC LOCOMOTIVE
ILLUSTRATED AND DESCRIBED BY TONY STUART-JONES



THE prototype diesel electric locomotive "Lion", is the result of over two years research and design by a consortium of three companies, Associated Electrical Industries, The Birmingham Railway Carriage and Wagon Co. Ltd., and Sulzer Brothers Ltd.

Designed to the British Transport Commission's latest specifications for a type 4 locomotive with an output of over 2,000 h.p., "Lion" is believed to be the most powerful locomotive in the world, and should be capable of handling main line trains over long distances at high speeds.

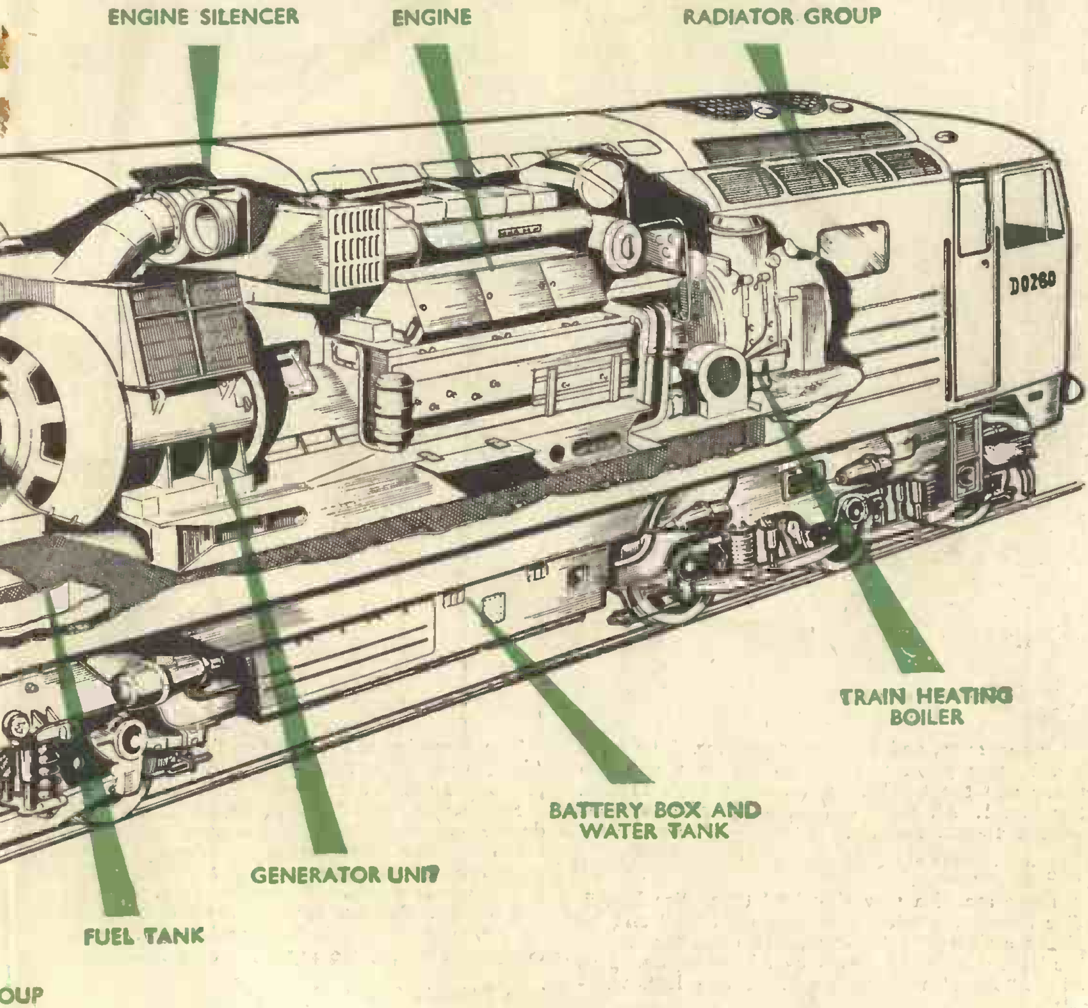
Brief Specification

Weight with fuel etc., 114 tons. Length overall 63ft 6in. Powered by a Sulzer diesel engine of 2,750 b.h.p. at 800 r.p.m. The wheel arrangement is of the co-co or six-wheel type bogie, and the maximum service speed is 100 m.p.h.

The Superstructure

This is of integral design, having no chassis, the body sides being stressed to form the main load carrying members. Built up from mild steel plate and pressings, in the form of a "Vinandeel" truss, the sides are insulated with asbestos and faced with a skin of 14G mild steel. Welded to the body sides is the underpan, with "Z" section solebars forming the bottom part of the bodyside girder. Situated at either end of the engine compartment, are the main bulkheads 3in. thick with a layer of glass fibre between. They are well insulated against heat and noise, making a high degree of comfort for the driver.

Thus it can be seen that this form of construction gives a torque resistant, rigid structure and achieves a great saving of weight without the use of a separate girder chassis.



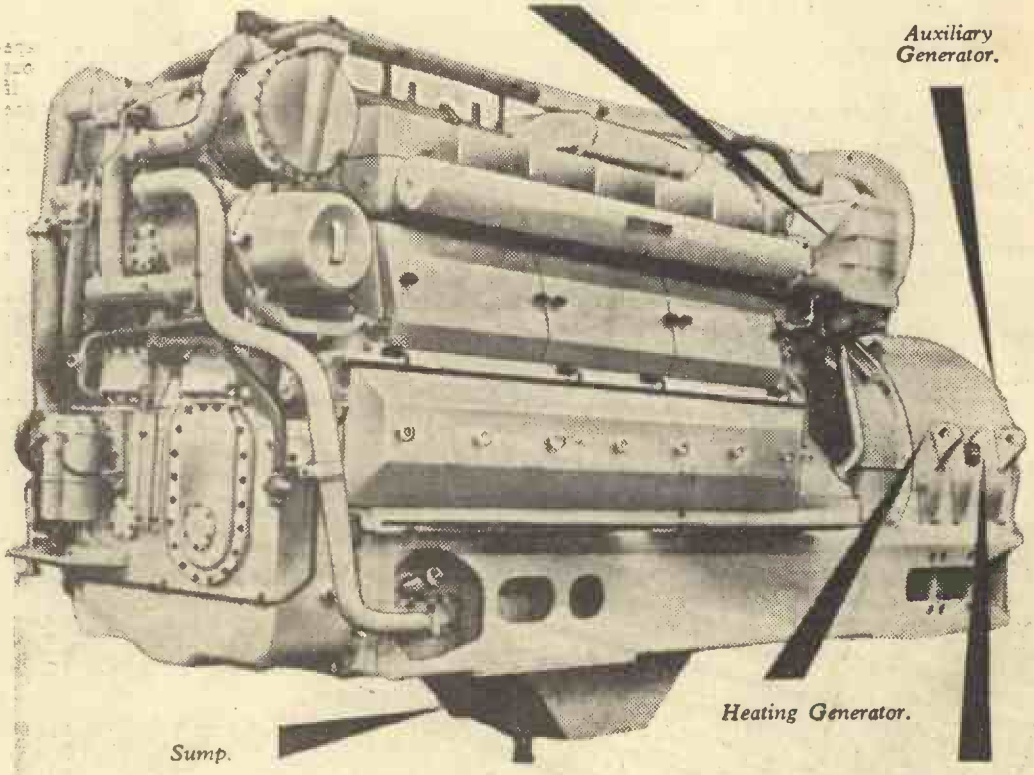
Perspective cut-away drawing shows how equipment is arranged internally.

The Engine

This is a new Sulzer diesel type 12LDA28-C of conventional o.h.v. design with an output of 2,750 b.h.p. at 800 r.p.m. and is a further development of the 2,500 b.h.p. 12LDA28-B model. By raising the crankshaft speed to 800 r.p.m., improving the intercooling, also redesigning the connecting rod and small end bearings has enabled the output to be increased to 2,750 b.h.p. on this new engine.

Basically the engine has 12 cylinders arranged in two "in line" banks of six. Each bank has a crankshaft and both are connected by a gearbox to the output shaft. In order to drive the generators, the crankshaft speed of 800 r.p.m. is raised by a synchronising gear step up to 1,150 r.p.m. on the output shaft. Mounted on the output shaft are three A.E.I. designed generators, arranged in tandem. In order, they are the heating generator, main generator, and auxiliary generator. The main and heating generators are housed in a common frame and the auxiliary generator outside of this. See Fig. 1. All three machines are insulated with silicone treated materials.

Fig. 1.—Diesel Engine and Generator used to power "Lion".



The Bogies

These are of a new six-wheel type. See Fig. 2. The frames are fabricated from mild steel and by giving each axle a loading of 19 tons, the weight has been distributed evenly over both bogies. This allows "Lion" to operate over all main lines without restriction.

Each axle has fitted an A.E.I. type 253 traction motor. By using silicone insulating materials they are of compact design with light weight giving a high power output.

The mounting of the body on the bogie is by the Alsthom system of twin rubber cone body support pivots and radius arm guided axles boxes.

Suspension is by conventional means, using double coil springs with dampers, giving good riding qualities. The brakes are operated by compressed air and each wheel has a cylinder with a piston which actuates the brake shoes through a rod linkage. Pressure is maintained in the system by a compressor and is connected to the operating equipment by flexible pipes for easy maintenance.

The Driver's Cab

This stretches the full width of the locomotive and is fitted with large front windows of gold film type glass giving maximum forward vision, and the finish is in a contemporary style of grey and blue

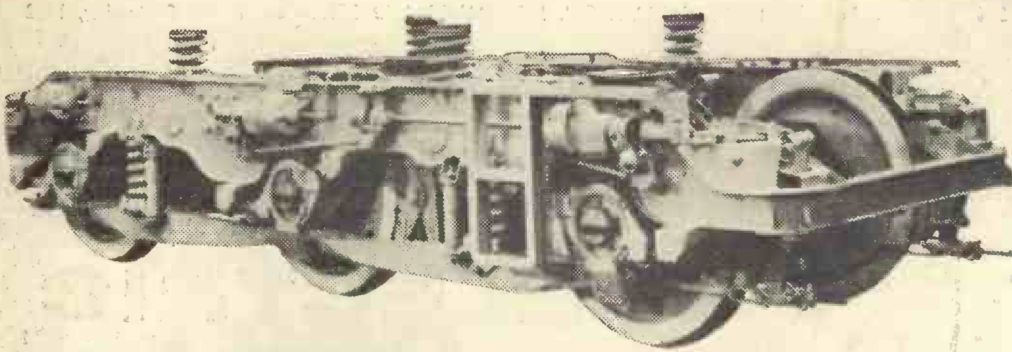


Fig. 2.—One of the Bogie units.

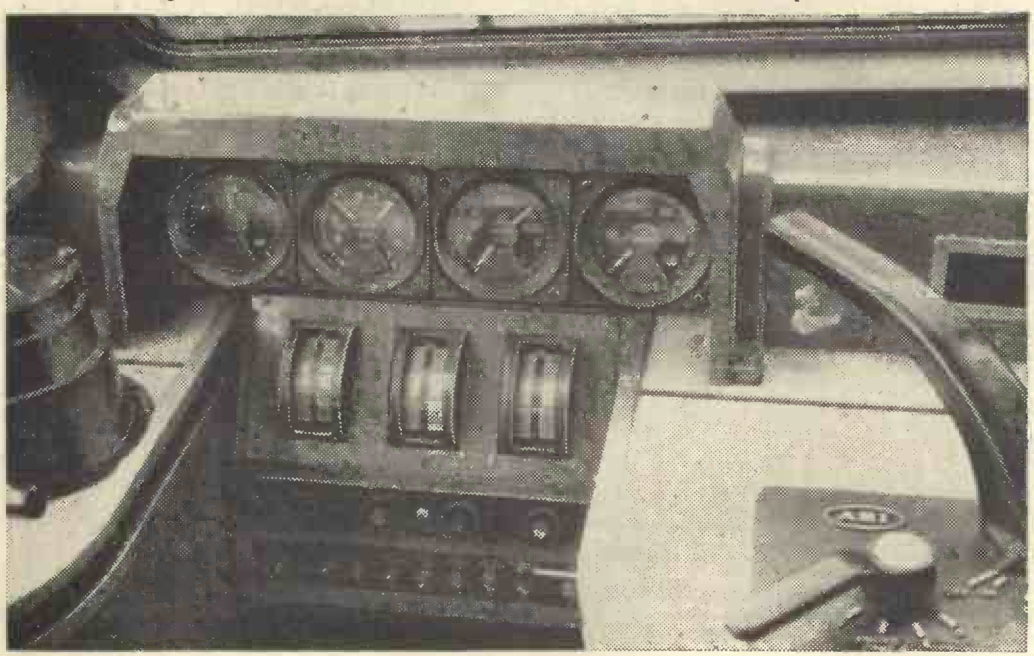
with polished wood facias. Situated at either side and forward of the draught-screens are the tip-up type seats for the crew. The driver sits on the left-hand side of the cab and in front of him are the contrdols, see Fig. 3. The layout of the controls follows standard British Railways practice with the addition of six ammeters to detect wheel slip. Mounted above these ammeters are four dials: Main reservoir pressure, Brake cylinder pressure, Vacuum Gauge and Speedometer. To the right of the driver, is the master controller power handle which controls the diesel engine by variations in air pressure. Other controls are operated by push-button or toggle switches. Panel illumination is by ultra-violet lights mounted in the canopy above, and the cab layout and controls are duplicated at either end of the locomotive.

Some interesting inovations have been incorporated in "Lion". The roof for instance, is made from fibreglass mouldings and above the engine-room is fitted a hatch made from translucent fibreglass panels. This hatch can be raised 6in. by a pneumatic system to allow hot air to escape quickly, so that maintenance can be carried out much sooner than would normally be possible. If required the hatch can be rolled clear, so that the engine may be removed and replaced. Incorporated in the hatch system is a safety device which prevents the locomotive moving whilst the hatch is raised. To facilitate easy maintenance many sub assemblies have been incorporated in the design, examples of which are, the radiator group, the resistance group, auxiliary group and many more.

Situated in the side of the locomotive is a door which is arranged so that the lower portion swings down to form a platform so that personnel may stand when refilling the underslung water tank from a standpipe.

At the time of going to Press, no orders from the British Transport Commission have been forthcoming but it is expected that when the test programme for "Lion" is completed a large order will follow.

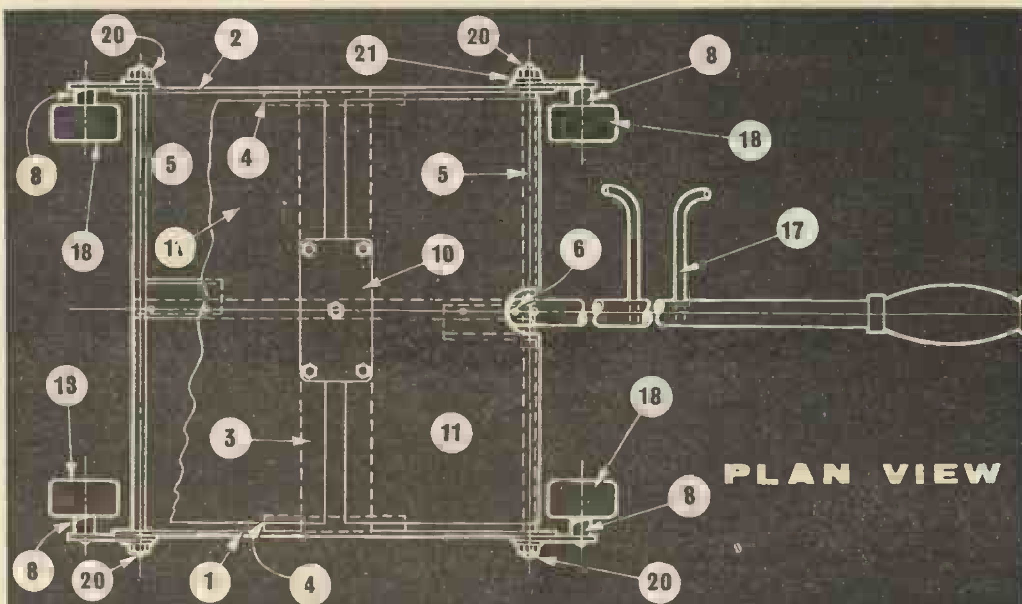
Fig. 3.—Photo shows instruments and controls in driver's compartment.



A LAWN MOWER ACCESSORY FOR AN ELECTRIC DRILL

BY H. J. JONES

THIS USEFUL ATTACHMENT CONVERTS A PORTABLE ELECTRIC DRILL TO TAKE SOME OF THE BACK-ACHE OUT OF GARDENING

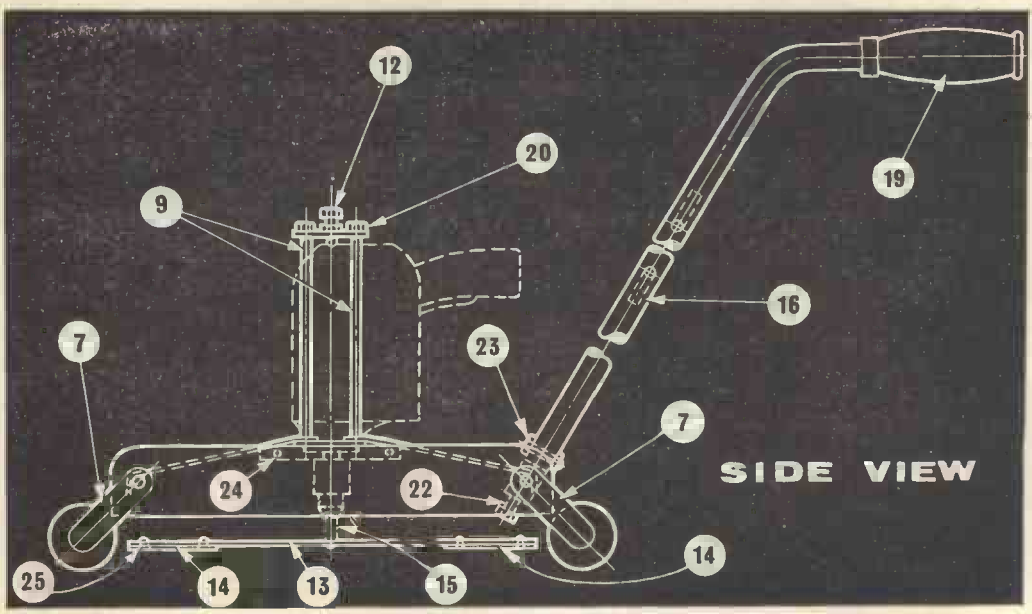


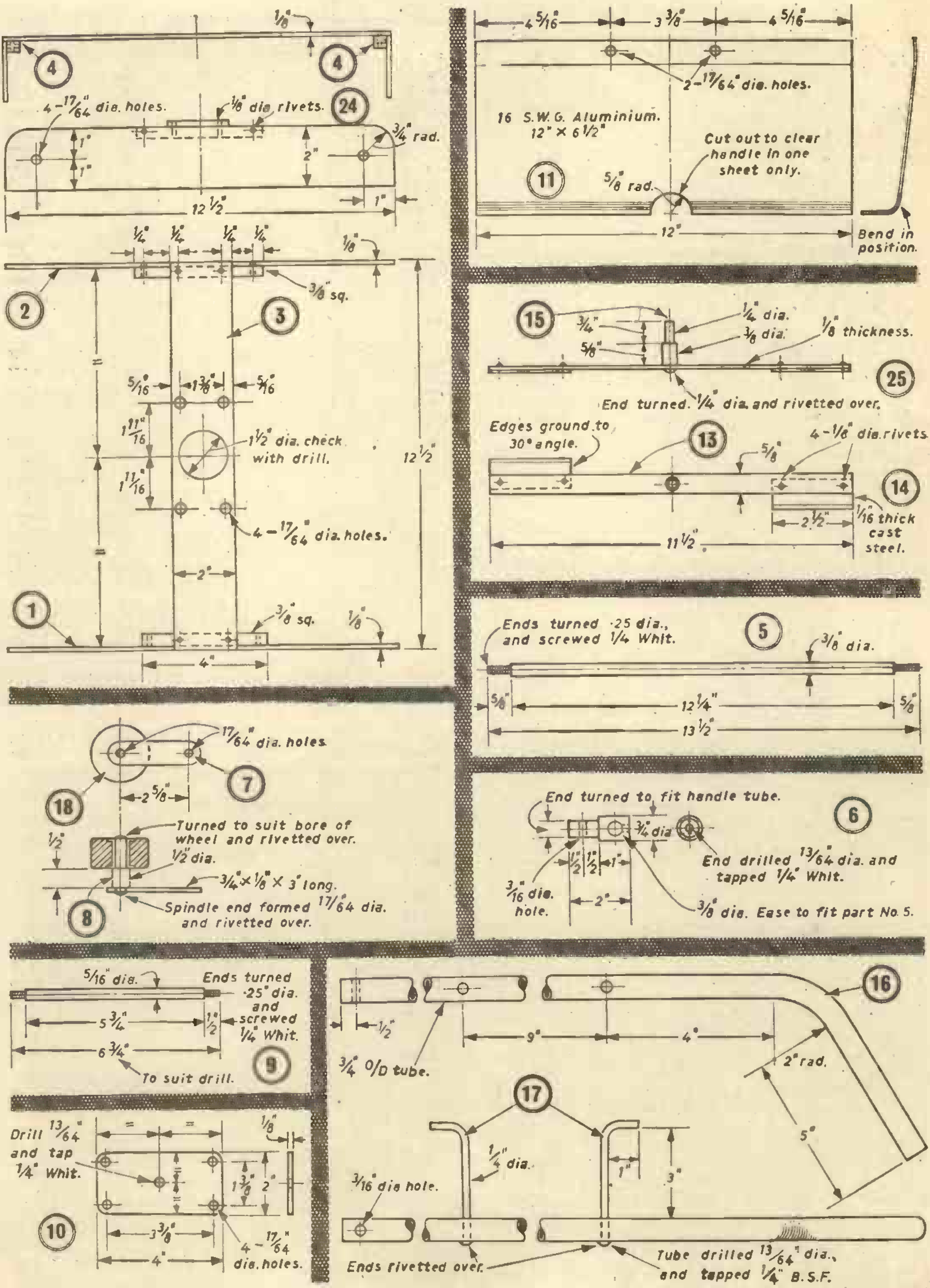
THE accessory about to be described converts a standard ¼in. electric drill into an efficient lawn mower. It makes light work of the arduous task of lawn mowing. Construction is comparatively simple and can be carried out with the aid of the electric drill and a few standard metalworking tools. A lathe is desirable though not absolutely necessary to make some of the parts. If no lathe is available the design of the parts can be modified.

MATERIAL LIST

Part No.	No. Required	Particulars.
1, 2, 3	3	2in. x 1/8in. thick Bright Mild Steel, 12½in. long.
4	2	3/8in. square Bright Mild Steel, 4in. long.
5	2	3/8in. dia. Bright Mild Steel, 13½in. long.
6	1	¾in. dia. Bright Mild Steel, 2in. long.
7	4	¾in. x 1/8in. thick Bright Mild Steel, 3in. long.
8	4	½in. dia. Bright Mild Steel, 1¾in. long.
9	4	5/16in. dia. Bright Mild Steel, 6¾in. long.
10	1	2in. x 1/8in. thick Bright Mild Steel, 4in. long.
11	2	16s.w.g. Aluminium sheet, 12in. x 6½in.
12	1	¼in. Whitworth bolt and nut, 1in. long.
13	1	5/8in. x 1/8in. thick Bright Mild Steel, 11½in. long.
14	2	1in. x 1/16in. thick Cast Steel, 2½in. long.
15	1	3/8in. dia. Silver Steel. 1½in. long.
16	1	¾in. outside dia. Mild Steel Tube, 3ft 3in. long.
17	2	¼in. dia. Bright Mild Steel, 5in. long.
18	4	Ball Bearing Roller Skate Wheels.
19	1	Rubber Handle, to suit Part No. 16.
20	12	¼in. Whitworth Nuts.
21	4	¼in. Spring Washers.
22	1	¼in. dia. Whitworth bolt, ¾in. long.
23	1	No. 2B.A. bolt and nut, 1in. long.
24	8	1/8in. dia. countersunk head Rivets, x 5/8in. long.
25	4	1/8in. dia. countersunk head Rivets, x ¼in. long.

The main frame is made first of all. File a radius on the top corners of Parts Nos. 1 and 2. Mark out and drill four 17/64in. dia. holes in the positions shown, also mark out and drill the four 1/8in. dia. holes for riveting Part No. 4 in position. Countersink these holes to suit the heads of the rivets to be used. Drill and countersink one 1/8in. dia. hole in Part No. 4 and rivet in place, then drill and countersink the second hole and fit the second rivet. Mark out the centre hole to fit the electric drill to be used, in Part No. 3, drill and file out to be a neat fit around the boss of the drill. Mark out and drill the 17/64in. dia. holes and also the 1/8in. dia. rivet holes in the ends. Countersink these on top. The ends of Part No. 5 are then turned down to ¼in. dia. for a length of 5/8in. and screwed ¼in. Whitworth. Part No. 6 is also turned to the dimensions shown and a 3/8in. dia. hole drilled through. The end is drilled 13/64in. dia. and tapped ¼in. Whitworth to suit the ¼in. Whitworth




4
4
1/8"
4-17/64" dia. holes.
1/8" dia rivets.
24
3/4" rad.
1"
1"
2"
12 1/2"
1"
1/4" 1/4" 1/4" 1/4"
1/8"
3/8" sq.
2
3
=
5/16" 1 3/8" 5/16"
1 11/16"
1 1/2" dia. check with drill.
1 11/16"
12 1/2"
4-17/64" dia. holes.
=
2"
1
3/8" sq.
1/8"
4"
4 5/16" 3 3/8" 4 5/16"
2-17/64" dia. holes.
16 S.W.G. Aluminium. 12" × 6 1/2"
Cut out to clear handle in one sheet only.
11
5/8" rad.
12"
Bend in position.
15
3/4"
5/8"
1/4" dia.
3/8" dia.
1/8" thickness.
25
End turned. 1/4" dia. and rivetted over.
Edges ground to 30° angle.
13
5/8"
4-1/8" dia. rivets.
14
2 1/2"
1/16" thick cast steel.
11 1/2"
Ends turned ·25 dia., and screwed 1/4 Whit.
5
3/8" dia.
5/8"
12 1/4"
5/8"
13 1/2"
17/64" dia. holes
7
18
2 5/8"
Turned to suit bore of wheel and rivetted over.
1/2"
1/2" dia.
3/4" × 1/8" × 3" long.
Spindle end formed 17/64 dia. and rivetted over.
8
End turned to fit handle tube.
6
3/4" dia
1/2" 1/2" 1"
End drilled 13/64" dia. and tapped 1/4" Whit.
3/16" dia. hole.
2"
3/8" dia. Ease to fit part No. 5.
5/16" dia.
Ends turned ·25" dia. and screwed 1/4" Whit.
5 3/4"
1/2"
6 3/4"
To suit drill.
9
1/2"
3/4" O/D tube.
9"
4"
16
2" rad.
5"
17
Drill 13/64" and tap 1/4" Whit.
=
=
1/8"
1 3/8"
2"
10
3 3/8"
4"
4-17/64" dia. holes.
1/4" dia.
3/16" dia hole.
1"
3"
Ends rivetted over.
Tube drilled 13/64" dia., and tapped 1/4" B.S.F.

bolt used to secure it in place. They are then assembled with Parts Nos. 1 and 2 and then Part No. 3 is riveted in place after drilling the necessary holes in Part No. 4. Parts Nos. 7 and 8 can then be made. Part No. 7 has two $\frac{17}{64}$in. dia. drilled holes and the ends filed to a radius of $\frac{3}{8}$in. Parts No. 8 are turned in the lathe to the instructions given in the drawing, and fitted to the rolled skate wheels, the ends of the spindles being riveted over.

The other ends of the spindles are riveted to Parts No. 7. These wheel assemblies are bolted to the main frame using spring washers to effect a secure hold. It will be noticed that by varying the angle of Parts No. 7 the frame can be raised or lowered. This adjustment is used to alter the depth of cut of the mower blade.

Parts Nos. 9 and 10 are then made to the instructions given in the drawing. Note that the length of Part No. 9 must suit the electric drill to be used. The aluminium top plates, Parts No. 11, are made next and assembled in conjunction with Parts No. 9. Part No. 10 is bolted in position and the $\frac{1}{4}$in. Whitworth set bolt and lock nut, Part No. 12, is put in place. This is for fixing the electric drill securely.

The handle, Part No. 16, is made from $\frac{3}{4}$in. outside dia. Mild Steel Tube. Conduit tubing or any other tube of this size will be suitable. The bend at the end can be made by heating to a dull red and placing in a $\frac{7}{8}$in. dia. hole in a thick piece of wood and bending gradually. If care is taken the bend can be made without kinking the metal. After bending, cool the metal off by dipping in cold water. Drill the $\frac{3}{16}$in. dia. hole in the end and also drill and tap the two $\frac{1}{4}$in. dia. B.S.F. holes for the cable holders, Parts No. 17, which are screwed in place, and then assemble in position with Part No. 6; a 2B.A. bolt 1in. long, and nut are used to secure. The handle can be removed for storing.

The last part to be made is the blade, Parts Nos. 13, 14 and 15. Part No. 15 is turned to the dimensions shown. It is advisable to anneal the silver steel bar before attempting the turning. This is done by heating it to a dull red colour and allowing it to cool slowly by placing in sand. Part No. 13 is drilled to enable the cast steel cutting edges, Part No. 14, to be riveted in place, and also to suit Part No. 15. When drilling the cast steel pieces, the $\frac{1}{8}$in. dia. end hole only is drilled in each and they are secured in place with one rivet and the other $\frac{1}{8}$in. dia. hole is then drilled. This ensures matching up correctly. The next operation is the hardening and tempering of the cast steel pieces. Heat to a cherry red colour and plunge into cold water. Clean up with emery cloth and then heat up gently with a moderate gas flame and wait until the colour at the cutting edge is a light yellow, then cool quickly again. The final operation is sharpening. Note that this is done on one side only of the cast steel pieces.

A coat of good enamel paint improves the appearance of the finished article and also prevents rusting. When the paint is properly hardened the electric drill may be placed in position, the blade fitted and the complete mower then tried out. It is advisable to see that the lawn is free from small stones as these will damage the blade. A long cable will be required to enable the mower to reach all parts of the lawn. It is a good plan to have a connecting box with a three-pin socket and switch connected to the mains and the electric drill plugged into this. If it should be necessary to join two lengths of cable, make use of the standard three pin connectors which are readily obtainable.

Never use the drill without an earth connection and always see that the mains is disconnected when fitting or removing the blade from the drill or when adjusting the depth of cut.

In use a slightly different technique from that necessary with the cylinder type of lawn mower, is required. It is better to divide the lawn into squares and cut one square at a time. This avoids getting mixed up with the cable. The mower cuts on the return stroke as well as the forward stroke.

WIRED RADIO SYSTEMS USED TO TRANSMIT PAY AS YOU VIEW TV

DEMONSTRATED recently in London, was a form of pre-payment television which utilises an existing wired radio system, as the carrier of the picture. Various forms of so called slot TV have been proposed from time to time, but the majority of these assume that the programmes will be sent out over the air in the ordinary way. There are various difficulties in this, not the least of which is how to ensure that only those who are entitled to will be able to pick the programme.

With the wired pay-TV system, the proposal is to use an existing circuit such as we have in various parts of the country and which is commonly known as a relay system. The relay network in London is claimed to be one of the largest in the world, and it has branches in almost every town, including Scotland. These provide six Channels at present, giving all the standard Sound programmes as well as the present TV programmes, having also spare channels upon which the future pay-TV programmes may be transmitted. For this system, a small box, provided with a coin slot is supplied to the viewer at a nominal charge, this is connected to the television receiver (which should preferably be of the modern dual-line type). When the viewer wishes to see one of the transmissions he inserts a two shilling piece in the slot, and switches on. The act of switching on operates a mechanism at the central transmitting point which sets into action various computers, operating every three minutes, and which automatically records the number of people who are viewing the programme, and the total amount which has been paid. If for any reason a viewer does not wish to continue looking he switches off, and the central recorder registers his departure, but the machine automatically remains set to make use of the remainder of his payments at a later period.

Amateur Climatological Station

Part One

CONSTRUCTION OF A GAUGE & STEVENSON BOX

By A. Crawfoot

AN amateur Climatological Station provides the owner with a hobby of never ending interest. It is one of the very few hobbies that will allow him to assist the professional, particularly if his station is at a good distance from an official station. His records, if carefully kept over a long period, are of great value, and should be treated as such. It should be borne in mind that the station is not a forecasting station. This can only be done by those who have access to information from stations covering a very large area.

It is true that observations can assist to forecast weather for the very near future. The conditions that bring certain weather such as rain, storms, wind, snow, etc., are preceded by changes in air pressure, temperature, humidity, evaporation, cloud changes, and many other things that point directly to the change. When these changes make themselves manifest it should be remembered that the change has taken place and is moving up towards you. Noting the change is not forecasting, but remarking on known conditions.

The station will give you a picture of the climate at the station over a period of time. I say at the station deliberately, because I have seen 2in. of rain fall less than three-quarters of a mile from my place, where no rain at all was registered by the gauge. The records of the station, in conjuction with those from other stations form a composite picture of the weather in a particular country. The climate of that country, and of the world is slowly changing, and your station can well help to record that change.

The station must have a number of instruments, most of which can be built at home by anyone with an aptitude for that sort of work. Often, other instruments, such as those from aircraft can be used or adapted for use. An altimeter makes a very accurate barometer. The instruments needed for a good station are a rain gauge, barometer, or barograph, a thermometer, or thermograph, wet and dry bulb thermometers. evaporimeter and anemometer. You will also need a Stevenson Box to keep instruments in that are placed out in the garden. A sunshine recorder is also a useful piece of equipment if you care to spend the money.

Another instrument which is not part of any official weather station is a seismograph, an instrument that normally is used for earthquake recording, but with which an enormous amount of research is being conducted all over the world in the detection and tracking of cyclones. Other phrases of weather observations can be deduced from these records, but little has been done in this line, and, without doubt this opens out a wonderful field for the amateur to construct and run this instrument. His research cannot fail to be of use to the community. If you intend to build a station in your garden as a separate building, keep it well away from any open space that you may have, as you will need this for your other instruments. The building should be as big as you can afford, and if you intend to install a seismograph, sub-divide a section at least 8ft x 6ft for this purpose. This section must be light proof at all times, and fitted with a red light as well as a white one. The whole building should be about 16ft x 8ft with a concrete floor. The floor should be in two sections. The seismograph room, or vault, as it is called should have the floor at least 2in. clear of main floor with the space inside the vault so that the partition is built on the main floor. Line the vault with a soft building board to help in temperature insulation. No windows are fitted to this part, but a ventilator should be installed high up. It should be as near as possible, draught proof. The main part of the building should be fitted with a work bench and windows, but leave a clear wall for the anemometer and remote registration evaporimeter. The building itself can be constructed of any material you wish.

Constructing the Rain Gauge

Before commencing work on the rain gauge, ascertain the size of the catchment funnel and the height above ground. Do not consider building a float operated gauge. Under these circumstances a float is by no means accurate. It will hold against the surface tension of the water over several points, and there is no guarantee that when emptied the water will return to the same level. A few days of no rain will evaporate some of the water, and a further inaccuracy will creep in there. Measurement can only be made by retaining the water that has passed through the gauge and carefully measuring in a special glass.

Rain is measured in points, 100 points being 1in. It is obvious that measurements of 1/100in. cannot be made by ordinary means, and some means of magnification must be used. Most measuring glasses are $\frac{1}{10}$th the area of the intake funnel so that one point of rain will show as $\frac{1}{10}$in. These glasses are quite reasonable to purchase.

Next obtain an ordinary funnel, the opening of which is a little larger than the size you require. Remove the "tail" and close the opening to $\frac{1}{4}$in.

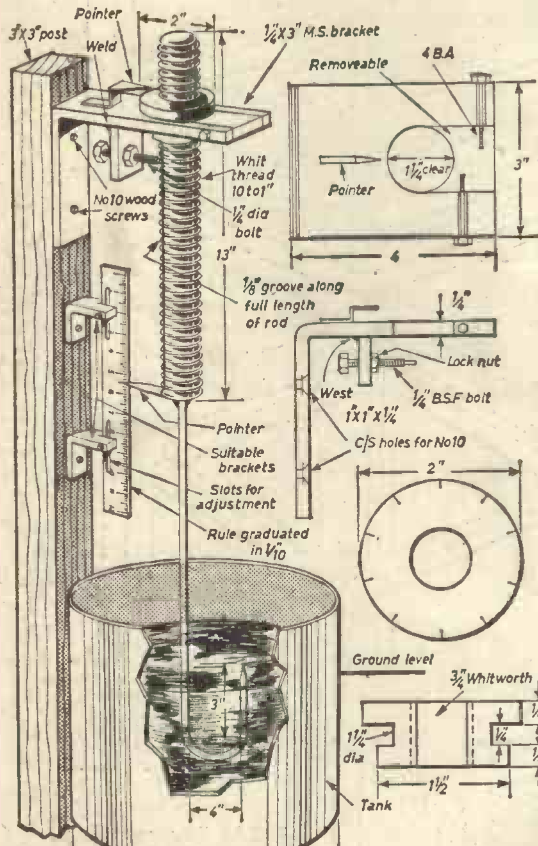
Next cut a strip of tin 1¼in. wide to form the rim. The rim *must* be tapered in at the top, the diameter being exact at the top. This taper is important. It is to cut the rain cleanly at the given size, and to assist in preventing any splash out during a high wind. Next make up the water container. It is best to make up two, as one could get filled up before the normal time for reading, and it is then a simple matter to change the container over and measure what has been caught to date. Paint the funnel and the container gloss white inside and out. Keep painted, as this helps to reduce any evaporation in the container after the rain has stopped.

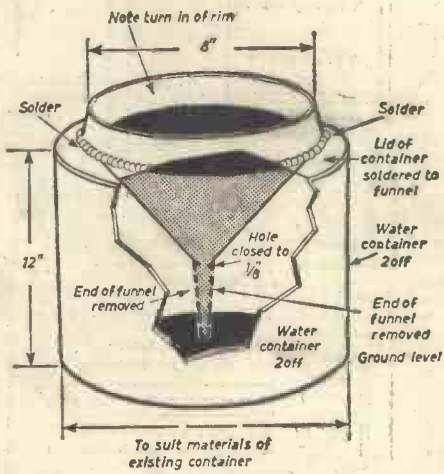
To position your gauge, place it as far from trees, buildings and fences as you possibly can. Place it dead level, and make sure that it cannot be blown over during a high wind. Four iron pegs driven into the ground to form a "cage" is as good as anything.

The Stevenson Box

The next part of the equipment is the Stevenson Box. As all readings are shade readings this means that thermometers and barometers should be kept in the shade and under continuous similarity of conditions, a container that will allow free circulation of air from any direction that it is blowing, without draughts is essential. The Stevenson Box supplies these conditions. The box is 3ft square outside, and is constructed from 2in. x 2in. planed pine framing with 4in. x ½in. planed cladding outside and inside, the boards being alternated so as to break up any direction wind blowing on to the box. The bottom is double in the same way as the sides. The top is also double in the same way, plus a separate "roof". When completed, the box gives a perfectly free circulation of air round the instruments without any direct sunshine inside.

Make up the two side frames first, the bottom rail is 2ft 11in. long and a ½in. tenon 1¾in. long is cut on each end. The back stud is 1ft 9in. high, and is morticed in the same way. Be careful of the angles of the top mortices. To obtain these angles the easy way, lay the bottom rail and the two studs on the bench (the mortices and tenons being in place) square the angles, then lay the top rail across the two and mark the angles of both the mortices and the tenons on the rail. Before assembling, cut the checks in the front and back of the studs for the bottom and top rails. These checks should be 1¾in. high by 1in. x 1in. Cut the tenons on the bottom and top rails to suit the check, so that the front and back rails, when in position, fit snugly. The rails



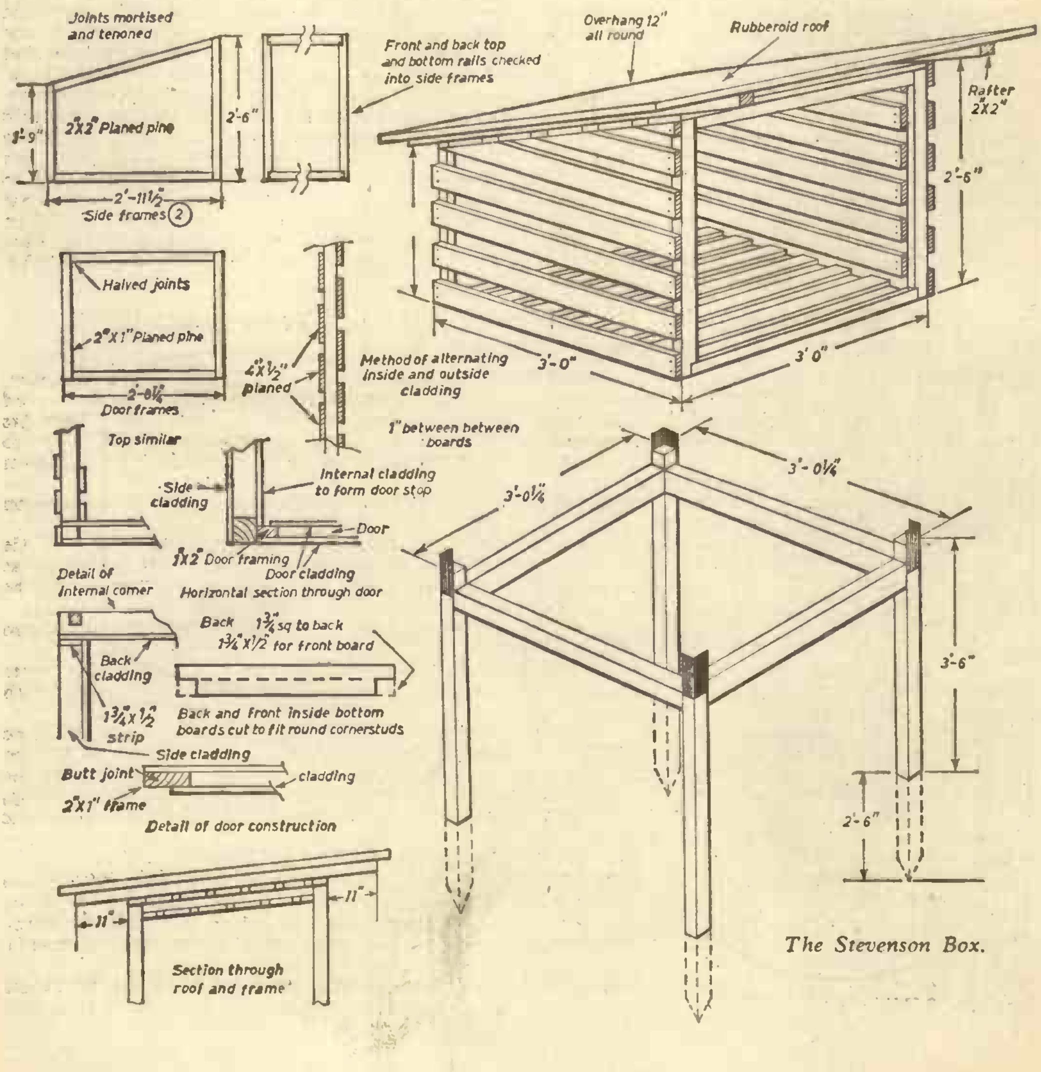


The Rain Gauge.

are, of course checked out to suit. All the joints should be well glued with a waterproof glue, and a nail or screw through will help to strengthen them. Now cut four pieces of 4in. x ½in, 2ft 11½in. long. In one of them cut a piece from each end

$1\frac{3}{4}$in. from the end and $\frac{1}{2}$in. deep. This is the front internal bottom. For the back, cut out $1\frac{3}{4}$in. square from each end. Stand the two end frames up on the bench and fit the two bottom boards at the front and back. These should be well glued and nailed. Next nail the other two plain boards on the top, flush with the front and back rails. Now cut the other bottom boards in, keeping them as near as possible to 1in. apart. The top is then treated in the same way. Turn the box upside down on the bench and fix the internal cladding to the roof. Then fix a strip of $1\frac{3}{4}$in. x $\frac{1}{2}$in. on to the cladding, flush with the inside of the framing. This is to carry the ends of the inside boards where they cut up on to the roof. Now fix the inside cladding to the back. This is a little awkward but not difficult. The bottom board should be kept down tight on to the floor of the box. The spacing of these boards can be kept at 1in. as the top board will have to be cut to width. Before fixing these boards, make certain that the back is square. The sides are fixed to a strip the same size as that underneath the top. These two pieces are fixed on top of the cladding boards in the same way.

The side boards are fixed in the same way as the back, the first being kept down tight on the bottom. Space at 1in. the same. Above the eave of the back, the boards will have to be cut on to the angle, of the roof and fixed to the strip. Before fixing the outside cladding, give the outer part of the box at least three good coats of white paint. This will of course apply to the inside of the outside boards. When fixing the outside cladding, do not glue, but the boards should be screwed, so that they can be removed for repainting when needed. This does not apply in the same way to the top, as this is covered with the outer roof and well protected from the weather. The first or bottom board of the outside cladding is reduced to $1\frac{3}{4}$in. wide, and screwed flush with the bottom of the bottom rail. This is to allow any water running down inside the walls to run straight out.



The Stevenson Box.

The door is framed from 2in. x 1in. planed pine. The two rails (top and bottom) are cut to length, leaving about ¼in. clearance. The two styles are then cut in between the rails. Before putting together, drill a number of holes through the bottom rail to allow water to drain out. The framing is best fastened with corrugated fasteners and the cladding glued and screwed inside, and screwed only outside. The hinges should be ordinary T hinges, and the fastener a hasp and staple.

The roof is formed by fixing two pieces of 2in. x 2in. planed over the top of the side frames. These should have an overhang of 11in. back and front. The top is screwed to these, and is formed of 4in. x ½in. boarding with the joints close, but not cramped, as any moisture getting on to the boards will cause them to swell and buckle. The boards overhang the " rafters " by 1in., and by 12in. at the sides. The whole thing is covered by a bitumen felt product to make it water tight. Paint the whole box glass white and keep well painted and clean.

The box is mounted on a stand about 3ft 6in. high. The actual height is governed by the height of the person using it. The centre of the door should be at eye level. Four pieces of 3in. x 3in. form the legs. The length is about 6ft, 2ft 6in. in the ground and 3ft 6in. out. Four 2in. x 3in. rails are morticed and tenoned round the top, 2in. down from the top of the posts. The outside size is 3ft ¼in. square. Four pieces of either 2in. x 2in. or 3in. x 3in. angle iron 6in. long are screwed on to the outside corners of the legs, leaving 3in. above the leg. Set the box in to the angle irons and screw tight. If the box is in a very exposed position fit braces on each side, but normally, if the posts are well rammed into the ground this is not needed.

The instruments can be placed anywhere in the box. For the wet and dry thermometers, fix a strip of ½in. timber, about 2in. wide across the inside of the box. The height should be enough to be able to place a small glass of water underneath one of the thermometers. A note here on the use of the thermometers would be in line. The dry instrument gives the temperature of the air, whilst the wet instrument gives the temperature when the bulb is exposed to evaporation of water. The difference in the temperature gives the relative humidity of the air. The instruments are usually bought as a matched pair. They are hung side by side on the cross strip of timber. One thermometer has a piece of linen tied over the bulb by a length of thick cotton string. This string dips into the glass of water. It should be long enough to lay on the bottom. The water is drawn up on to the bulb and there evaporates. The temperature is reduced, and the greater the evaporation, the lower the moisture content of the air. The difference in the readings between the wet and dry bulbs are read off a chart, and the relative humidity obtained. If both bulbs show the same reading (an unlikely occurence) the humidity is 100%. A dry bulb reading of say—64deg and a wet bulb of 56deg gives a relative humidity of 59%, 100% humidity means that the air is fully saturated and unable to absorb any more water. The later means that another 44% moisture could be absorbed before reaching dew point. The full implication of this cannot be discussed here as it would be far too lengthy.

Patterson's Electronic Beer Warmer

by STUART STANLEY KIND

"THE impact of the refrigerator on modern society", said Patterson, taking a swig at his beer, " has as one of its primary effects induced an attitude of mind which for want of a better word I shall call ' thermophobia '." He gazed proudly at the ceiling before continuing. " This has advanced to the stage where in the most progressive households canned beans are kept iced prior to heating. Alongside the canned beans is kept the bottled beer. I have taken steps therefore to market Patterson's Patent Electronic Beer Warmer ".

My half-formed query was silenced by an imperious wave of Patterson's hand, which in one motion silenced me and ordered two more pints from the waiter.

" You may well ask ", continued Patterson, " why a beer warmer? The answer is that English Ale is not meant to be served iced and sooner or later it will be realised that this perversion, imported as it was from America with its predilection for Germanic aerated waters, is out of keeping with the English character. When that time comes I shall be ready.

" Each refrigerator will be fitted, before sale, with a beer warmer. These will run on the immersion heater principle and each will be fitted with a thermostat.

" On removal of the beer bottle from the refrigerator, the cap is removed and the stem of the heater plunged down into the beer. The low temperature of the beer will actuate a bimetallic strip, which will close a low voltage circuit in the heating current ".

Patterson burped softly and went on. " The heater is rated at 50kW and so you see the heating time is critical. Assuming that the beer bottle holds one imperial pint and taking a reasonable value for the calorific equivalent of the bottle then a heating time of 0·783 seconds is indicated. This will raise the temperature of the beer from 5deg centigrade to a reasonable 20deg centigrade. It is necessary of course, for there to be some beer in the bottle in the first place ", said Patterson ostentatiously viewing me through the desiccated bottom of his pint pot.

Two more pints appeared and Patterson contentedly continued.

" Too short a heating time will not be satisfactory, too long a heating time will cause the beer to boil in about 3·9 seconds, which, having regard to the rate of heating will cause a violent explosion.

" At least, it would cause an explosion if the warmer were not fitted with Patterson's Patent Thermometric Cut-Out. This of course will increase the cost slightly but the safety factor is enormously increased and so it is well worth it.

" I can see it now ", he breathed with the eyes of one who has a vision, " every family with a Patterson's Beer Warmer ".

L.B.S.C's $3\frac{1}{2}$in. Gauge EVENING STAR

PART 19
FIREBOX AND COMBUSTION CHAMBER

The front edge of the paper should be flush with the upper part of the throatplate. Snip off the lower part to the same angle as the throatplate. On the lower and back edges of the paper, mark with a pencil the outlines of the bottom edges of the firebox, and the edge of the firebox backhead, and cut away the surplus paper. The result should be a paper replica of the firebox wrapper sheet.

Remove it from the throatplate, flatten it out, lay it on a piece of $\frac{3}{32}$in. (13-gauge) sheet copper, and scribe around it, to mark the outline on the copper. Alternatively, stick the paper pattern on the copper, same as a kiddy would do with a fretsaw pattern; then saw and file to outline. If the copper is hard, soften it as described previously, then bend it to shape, so that it fits closely to the throatplate flange. Mark off the location of the corner bends, then put a piece of round steel rod in the vice jaws. This should be about $\frac{9}{16}$in. dia. and project about 7in. from the side of the vice. Lay the copper over the rod at the place where the bend is to be, and give each side a good hearty downward press simultaneously. Beginners will be surprised how easily the bend is made. Ditto repeat at the other top corner, then try the wrapper over the throatplate flange. Naturally it won't fit exactly at first go, but it won't want much coaxing to get it fitting nicely over the flange. Clean around the inside, where the wrapper is in contact with the flange, with coarse emery cloth or similar abrasive; then rivet the wrapper to the flange with $\frac{3}{32}$in. copper rivets. Only a few are needed, say about $1\frac{1}{2}$in. apart. They have nothing to do with the strength of the boiler, being merely for the purpose of keeping the parts together while the brazing job is under way. No need for fancy snapped heads, as they are filed flush after brazing.

Assembly

The next item is to fit the barrel to the throatplate. Try it in place, and if it doesn't line up truly, with the shaped end of the barrel in close contact with the throatplate, teach it good manners with a file. The top of the barrel and top of the wrapper should form a straight line and the sides should be parallel also. I never bother about any fixture between barrel and throatplate; all I do is to stand the completed firebox shell in the brazing pan, with the barrel perched on top of it in correct position, and get busy with my oxy-acet blowpipe; but I don't recommend that lark for beginners and inexperienced coppersmiths.

To hold the assembly securely in place, rivet four locating tags to the inside of the barrel. They are 1in. lengths of 16-gauge copper about $\frac{3}{8}$in. wide, and should project about $\frac{1}{2}$in. from the barrel. Push them through the big hole in the throatplate when fitting the barrel for keeps, and when it is correctly located, knock back the ends of the tags against the inside of the throatplate. That will prevent the barrel shifting while brazing the joint.

First Brazing Job

Put a layer of small coke or blacksmith's breeze in the bottom of the pan, and stand the assembly on it with the barrel pointing to the sky. Pile up the coke at sides and back almost to the level of the throatplate, and inside the wrapper to about 1in. below it. Mix up some flux to a creamy paste with water, and well cover the points with it, especially the top corners where barrel, wrapper and throatplate form a sort of triangle, and at the side joints between wrapper and throatplate, below the barrel. Have everything handy close to the pan, which should stand on an iron frame, or a few bricks at each side would do. If using a blowlamp, see that there is plenty of paraffin in it, as the job will be spoiled if it goes out when the boiler is hot, and get it going good and strong to start with. Tip for beginners: the secret of good brazing is ample heat in the right place, plus clean metal.

Heat the assembly evenly by moving the flame about over the copper, then play on the coke around and inside it. When the coke glows red, concentrate the flame on one bottom corner of the throatplate. When that reaches bright red, dip the piece of brazing strip into the flux, then apply it to the joint in the flame. If the heat is right, the end of the strip will melt and flow into the joint. Now move the flame along very slowly, an inch or so at a time, and as the copper glows bright red, apply more brazing strip, dipping it in the flux at each application. When the barrel is reached, keep right on, playing the flame on barrel, wrapper and throatplate, and feeding in the brazing material as the metal becomes red under the flame. When you get to the top, where the barrel separates from the joint between throatplate and wrapper, direct the flame so that the lot is heated simultaneously. The flame of a 5-pint blowlamp is plenty big enough for this when working at full power. Feed in plenty of brazing material, and fill up the whole corner to a flush surface, the molten spelter forming a fillet against the barrel.

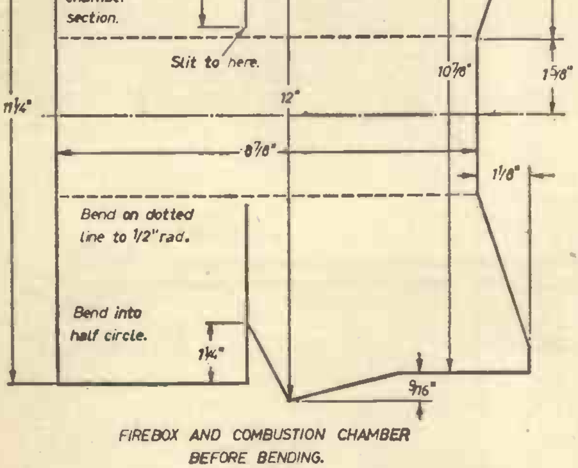
Carry on over the top, give the other corner a dose of the same medicine, then work your way downwards. When the lower part of the barrel is reached, where it leaves the side of the wrapper to form the "belly" part, play the flame direct on the joint between barrel and throatplate, and feed in sufficient brazing material to form a fillet. When the end of the joint is finally reached, at the point where the barrel meets the wrapper again, give an extra blow-up, and feed in more spelter to ensure that the joint is continuous and perfectly sound. If, during the operation, there is any bubbling of the molten spelter, scratch it with the pointed wire, in the flame, otherwise what are known as borax bubbles or blisters will form, and leakage will develop. Then finish off the side joint.

Finally, let the job cool to black, then carefully put it in the pickle bath—and mind the splashes! Let it soak 15 minutes or so, then fish it out, well wash in running water, and clean it up with a handful of steel wool, or some domestic scouring powder.

Firebox and Combustion Chamber

The top and sides of the firebox and the barrel of the combustion chamber are made from a single sheet of 13-gauge copper, measuring 12in. x 10in. To assist beginners and inexperienced coppersmiths I have shown in Fig. 122 the whole bag of tricks "in the flat". The first job is to mark out very carefully the outline shown to the given dimensions on a piece of thick brown paper or drawing paper. Cut it exactly to the outline and don't forget the deep slits at either side at 4in. from the straight edge. Bend up the paper template to the shape shown in the perspective sketch (Fig. 126) and fix the overlap at the bottom of the barrel section with a pin or a couple of paper clips. Now check off your paper dummy with the longitudinal and cross-sections of the firebox and combustion chamber shown in the general arrangement of the whole boiler. If OK go ahead and mark out the sheet of copper, using the paper template as a guide. Cut the copper to outline, soften it, bend to shape and fix the lap joint with four copper rivets to keep it close set while the brazing is under way.

Experienced coppersmiths can, of course, mark out direct on the 12in. x 10in. sheet of copper and bend up right away, but for tyros and first-timers it is far better—and cheaper!—to make the paper dummy first. If you spoil 20 pieces of paper all you lose is your time, but if you make an apple pie of just one sheet of copper, well—copper sheet is mighty expensive nowadays! 'Nuff said.



FIREBOX AND COMBUSTION CHAMBER BEFORE BENDING.

Fig. 122.

Firebox Throatplate

The front end of the firebox section is closed by a throatplate somewhat similar to the larger one previously described, but it has to extend only to the upper part of the barrel of the combustion chamber. As the throatplate and firebox doorplate are flanged over the same forming plate make this first. Use $\frac{1}{4}$in. iron or steel plate, cut to the shape of the firebox doorplate but $\frac{1}{16}$in. less in width at each side and $\frac{1}{2}$in. longer at bottom. File off the upper edge to the angle shown in Fig. 127 next issue. Alternatively use the cast-iron former which will be supplied by our advertisers. One edge of sides and top should be rounded off.

A piece of 13-gauge sheet copper 4in. x 5in. will be needed for the throatplate. Lay the former on it and scribe a line $\frac{5}{16}$in. away from each side, then cut away the superfluous metal. Set your dividers to 1$\frac{13}{16}$in. radius and on the centre line at 3$\frac{3}{4}$in. from the bottom strike the arc shown. Saw out the semi-circular segment, then grip former and plate together in the bench vice and flange the sides. Nick the flange at each side at 1$\frac{7}{8}$in. from the bottom and bend the lower part backwards as shown in Fig. 123 next issue. Clean the flanges with a coarse file and well clean the copper below the cut-away part to ensure sound brazed joints. Finally put the throatplate in position at the front of the firebox and rivet the flanges to the front end of the side sheets with five $\frac{3}{32}$in. copper rivets at each side.

Beginners especially note that flanges must be in the closest possible contact with the sides of the firebox and the front must butt up as tightly as possible against the edge of the combustion chamber. In full-size practice the joint is flanged and riveted, but the big boilers are not brazed and a flanged joint is needed to stand up to the stress. In the small boiler the brazing material forms a fillet, which replaces the flange and, if properly done, is actually stronger than the metal of the boiler itself. I've built a good many boilers with firebox throatplates made as above and have never had even a leak, let alone a failure. Experience teaches!

Firebox Doorplate

The firebox doorplate will need a piece of 13-gauge sheet copper 4$\frac{1}{8}$in. x 5in. Lay the forming plate on this with the upper edge $\frac{5}{16}$in. below the edge of the copper and scribe a line at each side $\frac{5}{16}$in. away from the former. Cut to outline, soften the copper, then grip copper and former together in the bench vice and flange the sides and top in the manner previously described, taking care to get the round corners at the top nicely bedded down to the edge of the former. At $\frac{1}{2}$in. from the bottom, at each side, nick the flanges and bend the plate as shown in Fig. 127 next issue.

A Hot-air gun for Welding Plastic

DESCRIBED BY
M. J. HARRISON

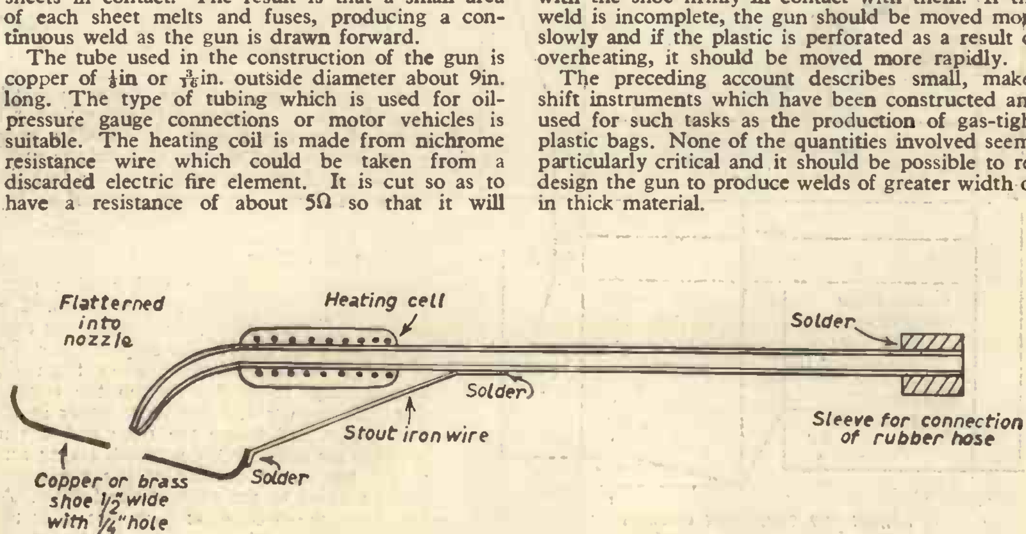
THE common method of making welds in thin sheets of polythene and other plastics involves contact between the sheet and a hot iron and consequently produces narrow regions of reduced strength and thickness on either side of the joint. This reduction in thickness is produced by the pressure of the iron whilst the plastic is molten. The method to be described does not have this disadvantage and has been shown to cause a slight thickening of the material near the weld with an improvement in strength. A further advantage of the method is that it can be used where the sheets to be joined are supported on porous surfaces or on material which yields and will not support the pressure of an iron. Situations of this type occur in such cases as the placing of plastic jackets on books.

The instrument used is shown in the diagram. It consists of a length of copper tube into which air at a low pressure is blown. This is heated as it passes through the gun by an electric heater dissipating about 30W and supplied by a transformer or accumulator battery. The air emerges at a high temperature and impinges on the plastic through a hole in a metal shoe which serves to hold the two sheets in contact. The result is that a small area of each sheet melts and fuses, producing a continuous weld as the gun is drawn forward.

The tube used in the construction of the gun is copper of $\frac{1}{8}$in or $\frac{3}{16}$in. outside diameter about 9in. long. The type of tubing which is used for oil-pressure gauge connections or motor vehicles is suitable. The heating coil is made from nichrome resistance wire which could be taken from a discarded electric fire element. It is cut so as to have a resistance of about 5Ω so that it will dissipate about 30W when connected to a 12V supply. If other supply potentials were to be used, the resistance of the coil would have to be modified. The coil is wound on to the tube after a length of about 1in. has been coated with "Pyruma" cement. Connections are made to it by twisting it tightly to lengths of insulated flexible and it is then embedded in a further, thick layer of cement. A jet is formed on the end of the tube by squeezing it with pliers until the opening is reduced to about 3 thousandths of an inch. It will then be about $\frac{1}{8}$in. wide and this will consequently be the width of the weld produced. The copper shoe is made from a strip $\frac{1}{2}$in. wide and $\frac{3}{4}$in. long, cut from stout sheet. The ends are bent up and the surface polished with fine emery cloth, to enable it to slide smoothly over the plastic.

The air pressure required to operate the gun is about 8lb/in.^{2} and can be obtained from a small compressor or foot-pump, or even by blowing down the tube by mouth. The gun can be used after the heater has been allowed about 30 seconds to heat up, this process being accelerated by not applying the air until the work is to be commenced. It is then drawn slowly across the surface to be joined with the shoe firmly in contact with them. If the weld is incomplete, the gun should be moved more slowly and if the plastic is perforated as a result of overheating, it should be moved more rapidly.

The preceding account describes small, makeshift instruments which have been constructed and used for such tasks as the production of gas-tight plastic bags. None of the quantities involved seems particularly critical and it should be possible to redesign the gun to produce welds of greater width or in thick material.



Perspective view of Gun.

SPACE SHOES

BY OUR SCIENCE CORRESPONDENT

Ceiling-stander secretary, Nancy Wendler, demonstrates a pair of zero gravity shoes for their developer, John F. Heard.

SPACE travel presents many problems. One of these, that scientists have been giving considerable attention to recently, is weightlessness.

One test, that the American astronaut John Glen was unable to perform, while recently orbiting the earth, was to attempt to walk while in a weightless condition. How he would have felt, when he weighed nothing at all, is a sensation yet to be experienced.

Once beyond the pull of the earth's gravity, an astronout can no longer " stand on his own feet ", as it were. Everything he does must become awkward and cumbersome. He is, in other words, a " floating object " with little, or no, control over his own movements. Unless, that is, he is securely fastened down. Even then he is not too mobile, although able to use his hands and feet for the manipulation of controls etc.

However, when space cabins increase in size, to where movement is necessary or desirable, the method of overcoming zero gravity must be overcome.

According to John F. Heard, a space applications engineer with the U.S. Martin Aircraft Company, this is no longer a problem. The force of gravity can now be overcome, and a person can—either here on earth, or in space—walk anywhere he pleases in the same manner as a fly does.

Mr. Heard has developed, what he terms, " zero gravity space shoes ". These shoes will permit future men-in-space to control their means of locomotion and orientation to physical components within the space cabin.

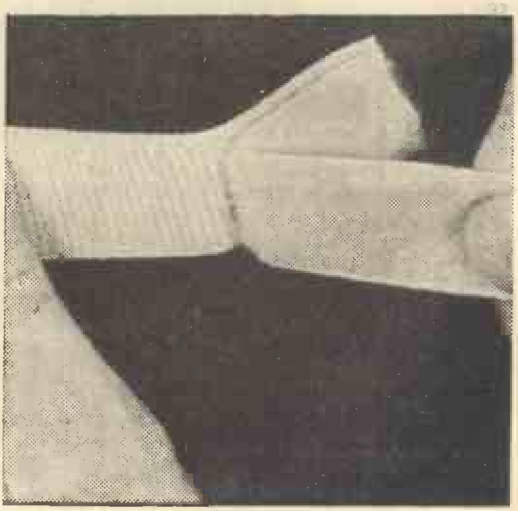
The shoe soles would be covered with a nylon fabric consisting of thousands of tiny, closely-spaced hooks. The floor of the space vehicle would be carpeted with a nylon pile " rug ". The hooks would engage the nylon fibres when the shoe comes in contact with the rug. When these minute nylon hooks engage with a carpeted surface, they create a fastening effect with a holding power capable to suspend the weight of an average size person. This is possible, even when walking on the ceiling upside down, with the earth's gravity pulling. In space, relatively small amounts of hooks would be required to keep an astronaut walking properly.

Laboratory tests, conducted by Mr. Heard at the Martin Aircraft Company in Denver, Colorado, have demonstrated an extreme holding tension capacity of 85lbs per shoe. Normal walking motions would start a peeling effect on the nylon material that releases each shoe for proper locomotion.

Other methods, such as suction cups and magnetised shoes have been suggested to overcome the problems that arise in a weightless environment. Magnets, however, would require a heavier surface for contact and could possibly interfere with the electronic equipment operating the space vehicle. Suction cups, on the other hand, will operate in a normal atmosphere, but will not function in an outer space vacuum.

The material, from which zero space gravity shoes would be made, was originally used, peculiarly enough, in the clothing industry as a type of " zipper " or fastener.

Demonstrating how the two materials " knit " together.



TRADE NEWS

Orbital Engine

THE revolutionary Orbital Engine—an internal combustion engine, which eliminates reciprocating motion and dispenses with connecting rods and crank shafts—is to be developed by a new company in Bristol headed by Lord Strathcona and Mount Royal.

The orbital engine is the invention of engineer Cecil Hughes. Only one prototype exists—a prototype which has enabled Hughes to prove his theories. Already it has excited world-wide interest.

In the past 18 months, the engine has been developed by the Southampton engineering firm of William R. Selwood Limited. Now, Selwoods have handed over their interest to the new firm, Orbital Engineering Limited, who will operate in a new building attached to the Kelston Engineering Company Limited at their factory in Kitchener Road, Lodge Causeway, Fishponds, Bristol. Lord Strathcona is a director of Kelston Engineering, and will be chairman of Orbital Engineering.

Kelston Engineering are themselves working on another invention of Mr. Hughes'—a contractor's pump which operates on a concertina principle. Since the pump's "unveiling" on May 2nd, inquiries for it have come in from all over the world. Different versions are now being developed for special purposes.

In the orbital engine, cylinders and pistons gyrate on orbits relatively inclined to one another, achieving compression without the use of reciprocation as in conventional engines, and removing the need to deal with inertia forces.

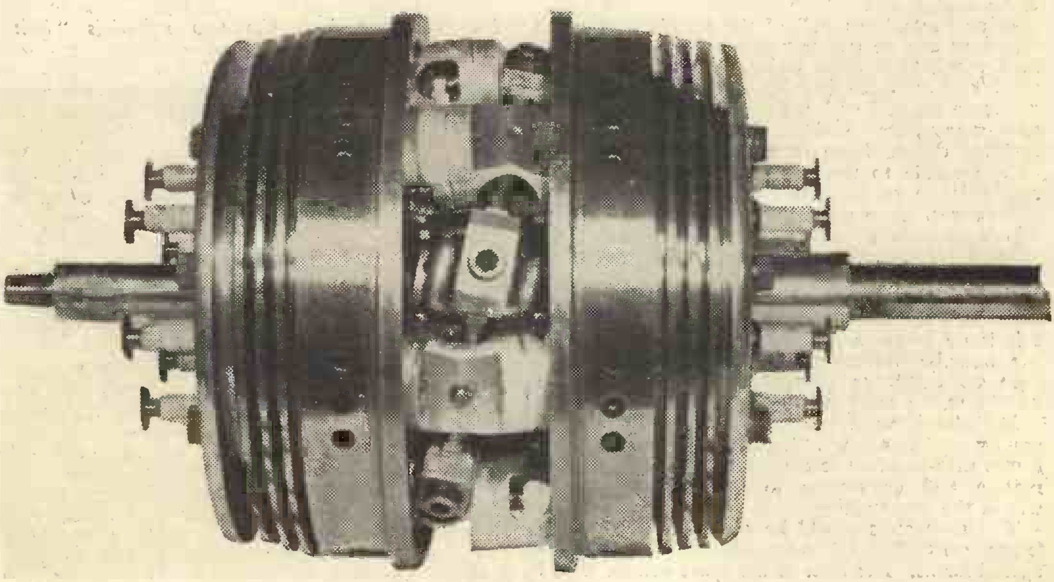
Lord Strathcona says that Kelston Engineering's precision machinery and highly-skilled labour force would enable Mr. Hughes to make significant advances in the development of the orbital engine.

"We know the theory is sound", he said. "All we have to do now is produce an engine to demonstrate the potential power of which this design is capable.

"Later developments will be based on experience largely gained from the prototype, and we shall finally evolve an engine with an unequalled power/weight ratio. It will clearly demonstrate the inherent freedom from vibration, unequalled smoothness of running, and the improved efficiency over the orthodox internal combustion engine, resulting in lower fuel consumption".

The orbital engine—the improved prototype will measure less than 1ft in diameter and weigh only 45lb—will not go into large-scale production in Bristol.

Orbital Engineering's aim is to offer it to firms throughout the world for manufacture under licence. "Naturally", Lord Strathcona said, "we hope British firms will be the first in the field".



Substantial Price Cut For Famous Home Workshop Drill

A DRAMATIC price cut is announced by Stanley-Bridges Limited for their well-known DR2T Neonic home workshop drill, shown in the photograph. It will be available as from Friday, 13th July at a new retail price of £6 19s. 6d.—nearly 17% lower than before.

There are more than 70 different attachments available for this drill. They enable it to be used for a wide variety of tasks in the workshop, garden and the home.

Clarke and Smith Orders 100 EMI Type 8 Cameras

CLARKE and Smith Ltd. has been granted marketing rights by EMI Electronics Ltd. for distribution of the Type 8 Television Camera to education authorities and the retail trade. This announcement came shortly after an order by Clarke and Smith for 100 EMI Type 8 Cameras.

From the time of the earliest village schoolmasters, children at the back of a classroom have had difficulty in seeing what was happening. With the increasing complexity of modern education the problem has grown, especially in laboratories or workshops where it is essential for the students to view intricate processes.

EMI has greatly eased the problem with the new Type 8 camera, which enables an entire class to view slides under a microscope, a close-up of a scientific experiment or a practical demonstration. For such purposes the camera is placed on the demonstration bench and the picture transmitted to one or more receivers strategically placed in the lecture room.

Commenting upon this marketing agreement, a spokesman for Clarke and Smith said:—

"At first we envisage selling the camera as an instrument to assist in demonstrations but we hope that it will eventually be used as a means of transmitting a lecture to several classrooms.

"Television in education has never really been fully developed due to its prohibitive cost. With this new camera, costing only £160, and a trolley mounted 27in. receiver, a basic installation costing as little as £300 can help to alleviate the present shortages of teachers by enabling them to handle much larger classes."

A Simple Sundial

By J. Morgan

Can be both ornamental and useful in your garden

NOW that summer is with us, some of you might like to make a very simple and most effective sundial. Unusual in shape, mine which has been in the garden for some years now, is always noticed and causes considerable interest to visitors.

One angle only has to be used—the angle of latitude—as against the many of the conventional dial.

Materials required

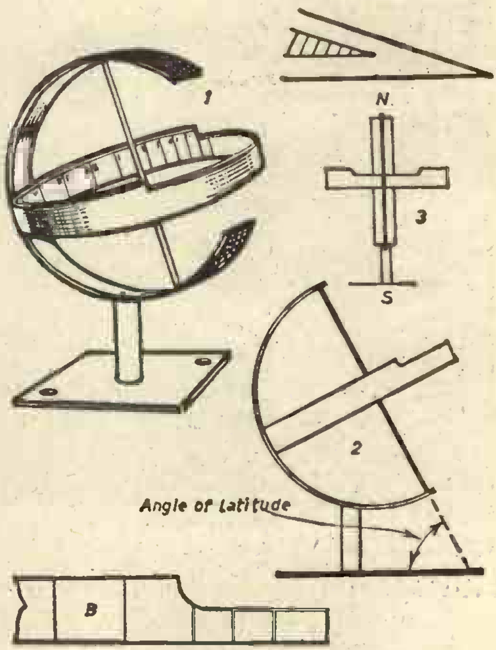
1ft by 2ft length of, say, 1in. by $\frac{1}{16}$in. strip for the hour circle. (Brass or Aluminium.)
1in. by 13in. length of ditto.
1in. by 7in. length of $\frac{1}{8}$in. round.
Two nuts $\frac{1}{8}$in. Whit. or equivalent sundry screws and rivets.
Material for vertical stand and base to taste.

Take the 2ft length; mark off into inches and scribe each inch mark deeply across the width.

At each end for a distance of about $2\frac{1}{2}$in. halve the width (as B).

The centre mark is numbered "12"; the lines to the left (with the cut away ends uppermost) 11, 10, back to about 3; and to the right, 1, 2 etc. to about 9. Stamp these in boldly—it is annoying to have to count back or forward from 12 each time, and remember during summer time, when the dial shows 12, it will, in fact be 1 o'clock. Now bend strip into true circle, marks inside, butt the ends together, and solder, braze, or what you will.

Next take the 13in. strip. Drill a $\frac{1}{8}$in. hole $\frac{1}{2}$in. from each end, i.e. exactly 12in. centre to centre. Centre this strip and mark off strip width across it. Drill holes for rivets. Thread $\frac{1}{8}$in. round rod for just over $\frac{1}{2}$in. at each end. Bend strip to approximate half circle, enter rod through two holes, put on nuts, and tighten same till this half ring will lie exactly on the ring previously made.



Constructional Details.

The completed Sundial.

Cut off surplus at each end. Place half ring inside full ring, squarely to scribed lines. (The 12 o'clock line will lie on the centre line of this half ring, and this is important if the shadow line is to fall exactly on the hour lines.) Mark and then drill for rivets. Withdraw round rod, place full ring inside half ring, rivet together, replace rod and nuts exactly as they were. Prepare base plate and pillar to taste.

The angle of latitude now has to be determined, and the parts fixed in position at this. On a piece of stiff card set out this angle and cut the triangle (see diagram). The shaded piece shown is better removed. Set this on base and hold rings until rod lies along edge. Drill, screw and I would suggest, solder, the parts together in this position. Check again because this angle is of prime importance. It now only remains to set the position North-South of the complete instrument. Use compass to set a line from rod to 12 o'clock line in this N/S direction, the rod of course being to the S. Incidentally, on only a couple of days in the year will this give exactly midday, but if you know all about this you will no doubt be able to set a more accurate N/S than by compass, and will know of the deviation either side we get according to the time of year.

Finally, lines of latitude across the country go so, 50° Lands End, 51° Bideford—New Romney (Kent), 52° Ipswich—Fishguard, 53° Boston—Stoke-on-Trent, 54° Harrogate, 55° Newcastle—Annan, 56° Firth of Forth—Clyde, 57° Braemar, 58° Lairg, 59° Orkney, 60° Shetland.

CONSTRUCTION WITH DRINKING STRAWS

By ALAN WARD

INCREDIBLY neat constructions of basic geometrical forms may be quickly assembled, using drinking straws and pipe cleaners as your only raw materials. The completed objects will possess great beauty and will be of special interest to young scientists for their resemblance to certain crystal forms and modern architectural works. Some of the completed models will seem unbelievably rigid for things so fundamentally " frail " and you will be able to understand why engineers employ such forms when building strong structural frameworks.

To begin with, you should appreciate that hollow drinking straws are really very strong when you consider that they are fashioned merely of tough waxed paper. In the human body, the long bones, like the thigh and bones of the arm, are tubular, and for this very reason they are admirably suited, from an engineer's viewpoint, to support the heavy weight of a man. The entire skeleton may only weigh twenty pounds. In your models the straws will be joined together by bent pieces of pipe cleaners. These may be twisted in various ways, as illustrated in Fig. 1, to obtain " linking pieces " bearing any required numbers of " prongs."

Commence your constructional experiments by building a TETRAHEDRON, or form having four faces, if we imagine that the space between the

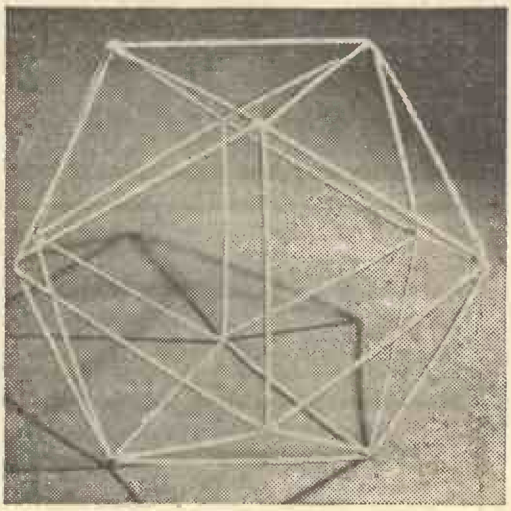


Fig. 1.

angles and sides is filled in to form a solid structure. You will need four 3-pronged linking pieces, plus six straws. As you work at this easy model, observe how "logical" or natural the structure is. Note the strength of your completed symmetrical figure. Proceed to make an OCTAHEDRON, or model of an eight-faced form. This time you will need six 4-pronged linking pieces, plus twelve straws. Observe again the strength of the finished structure. A crystal of the chemical substance alum is in the form of an octahedron.

A cube or HEXAHEDRON can be represented, using eight 3-pronged linking pieces and twelve straws, but this structure, not possessing the triangular faces, will not be rigid without reinforcement. Another non-rigid interesting form which you can build is a DODECAHEDRON, which possesses a total of twelve pentagonal or five-sided faces. You will need thirty straws and twenty 3-pronged linking pieces. Begin by joining up five straws to make a pentagon as base and then proceed to build upwards. The structure will virtually "build itself" once you have started, and the awareness you will have of creative progress is most satisfying.

So far you will have built the first four of what mathematicians call the "five regular solids". It remains for you to put together the most pleasing of them all, the twenty faced ICOSAHEDRON (do not be dismayed at these frightening names). All the twenty faces will be triangular, so you will already know that the end-product of your endeavours will be rigid. You will need thirty straws and twelve 5-pronged linking pieces. You will be advised to use a whole pipe cleaner to make each linking piece. Now, you should be able to build the icosahedron without further instructions. If your work is tidy and you do not bend the straws, you will be exceedingly pleased with the result.

Some of the models may be permanently secured at the corners, using balsa cement, and the completed forms painted in glossy primary colours to provide strikingly ornamental objects, like modern abstract sculpture. The shapes may be suspended from threads and they will provide much pleasure as they spin slowly around and present kaleidoscopic changes of regular linear patterns. The icosahedron is especially beautiful in this respect. You could cut up the straws and make sets of similar forms of diminishing sizes and different colours, or you could design mobiles featuring the objects aerially suspended from horizontal rods.

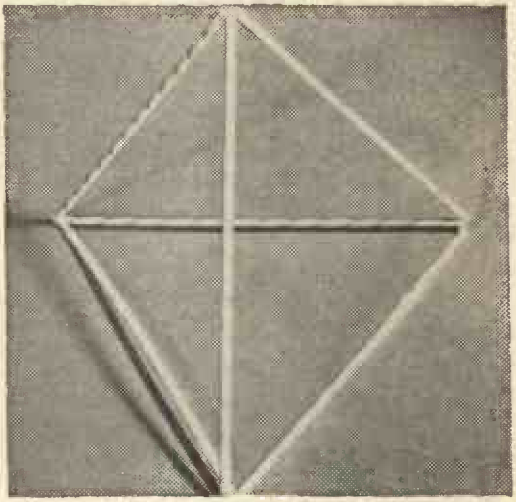


Fig. 2.

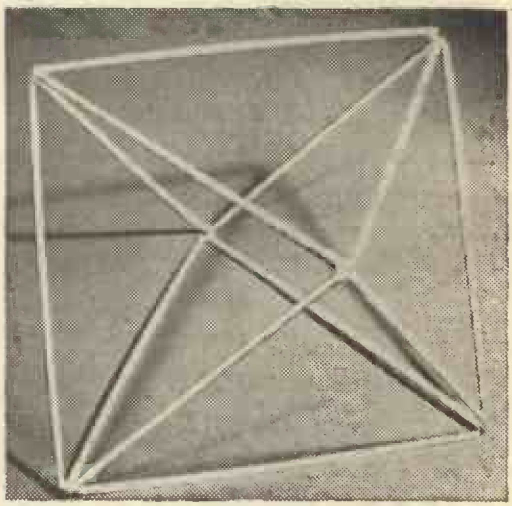


Fig. 3.

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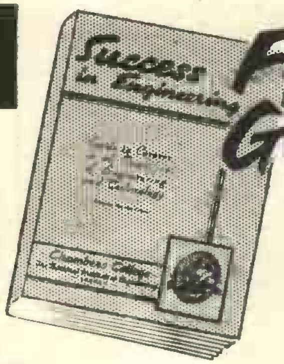

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